

# A Drop Water



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# A Drop of Water

By Margaret Horner Clyde

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"The Thread That is Spun"  
and other stories

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# A DROP OF WATER

## CHAPTER I

Have you ever watched steam rising from the spout of a tea-kettle? Where does it come from? Where does it go? You say it comes from the water boiling in the kettle. But what makes the water boil? You tell me heat, of course, from the fire under it.

My small friend Ted had never thought much about steam or fire until the day he went camping with Uncle Bob and Daddy. Of course, he had seen Nora, the maid, light the gas stove and put a kettle of fresh water on it to boil. And he had seen Mother pour Daddy's coffee steaming hot into his cup at breakfast. But just what happened to make the kettle boil or the cup of coffee give off steam he did not know. But he began to think about it the day they went camping.

It was a bright, cool day, just the day, Uncle Bob said, for the trout to bite. And Uncle Bob ought to know, for he went to college. And Daddy said that college boys knew everything there was to know—as well as a good deal that there wasn't. Which Ted could not understand at all. Any more than he could understand why Daddy called Uncle Bob a college boy when he was just as tall as Daddy himself and could beat him any day at tennis.

But Uncle Bob was right about the trout. They found that out as soon as they had pushed their way through the woods to the trout stream and had unpacked their fishing-rods.

All afternoon the two men fished while Ted ran up and down along the stream. He climbed the slippery rocks to see where the sun looked down between the trees. He watched the clouds that went like flocks of sheep across the sky. But, chiefly, he gathered twigs and branches with which to build a fire to cook their supper.

It was a good supper. There were sandwiches which Mother had packed that morning in a basket. There was also bacon that curled up like paper in the pan. And there was coffee, which Daddy would not let Ted taste. But first of all there had to be a fire.

It took almost a whole afternoon to gather wood enough to build it. And then when Daddy had laid the sticks so carefully criss-cross it would not burn.

"Humph," said Uncle Bob, "it didn't seem damp."

He struck a match and held it carefully in the hollow of his hand. A puff of wind came and blew it out.

Now Uncle Bob had been a Boy Scout leader and had taught the boys how to start a fire with one match. So he was a little ashamed when he had to strike a second and finally a third match before the fire would burn.

And all the while Ted was growing hungrier and hungrier. Would supper never be ready?

He looked back at the path through the woods by which they had come. He wondered how many miles it was to Nora and the gas stove.

But at last the fire burned. And the bacon sizzled. And the coffee boiled. And they opened the basket of sandwiches. And then they had supper.

After that it began to grow dark. And Ted crept closer to Daddy while Uncle Bob told him stories about the Indians who once lived in those woods. They built campfires too. Only they had no matches. In fact nobody had matches in those days.

"But how *could* they build a fire without matches?" he asked.

And then Uncle Bob told him how they rubbed two pieces of wood together until they burned.

He told him other things too about the Indians; how the men went hunting and brought home game; how the women cooked the meat over the fire; how the little babies were wrapped up tight and strapped to their mother's backs or perhaps hung up in a tree to be out of the way. An Indian baby, it seemed, was called a papoose.

And all the time Ted listened the woods were growing darker. The campfire made a ring of light. But outside of that ring was just blackness. He looked up to where the smoke was going. It was no longer blue up there and there were no clouds like flocks of sheep. It

was grey between the tree-tops and one star looked down as if it were watching them.

Ted shivered and crept still closer to Daddy.

"Cold?" said Daddy, and put his arm across Ted's shoulder.

Ted shook his head. "No," he answered. "That is, not much." For he was afraid Daddy might take his arm away. He did not want that. But it would not do to say so.

He thought about his little bed at home. About this time Mother usually read to him. Then she tucked him under the covers and put the light out. Mother must be lonely to-night. He was sorry for her, so sorry, in fact, that he began to have a queer feeling in his throat. This would not do.

He winked his eyes rather fast and looked up at the sky. The star was still there watching them. Then he looked back toward the path through the woods. It was not there. There was nothing there but blackness.

He had wondered in the afternoon how many miles it was back to Nora and the gas stove. That was because he was hungry. He was not hungry now. But he still had that queer feeling in his throat. It seemed, too, that there were things you could want worse than you wanted your supper. One of them was your mother.

"I suppose," he said, slowly, "we're about one million miles from home."

"One million!" Uncle Bob shouted. "Bless the boy, he doesn't know what a million means."

"Yes, I do," said Ted. "It means all the miles there are."

"Well," said Uncle Bob, "that's not so far wrong. Because if you were to start out and walk straight ahead, you could walk all the way around the earth and back again without walking a million miles. In fact the only way you could go a million miles straight ahead would be to fly up into the sky."

"Yes, sir," said Ted, politely. He was not listening very closely because there was such a rustling among the trees where the Indians were. And the star up above was winking at him.

And then Daddy was wrapping him in one of Uncle Bob's army blankets. At least that was what they said it was. But he knew better. And anyway it wasn't himself they were wrapping. It was that little Indian papoose and Mother was putting that little Indian papoose into his own bed at home. And then—

And then it was morning. And the trees were green, not black. And the star was gone. And the sun was shining down between the tree-tops. And they had slept all night in the woods.

## CHAPTER II

Ted was very busy one day in June. He was watching the men put in coal. He liked to see them back the truck across the pavement, turn the handle which wound and wound until the body of the truck stood high up above the wheels, then, as it tipped over, help the coal to slide down the chute into the cellar.

It was queer that coal would burn. It looked like stone. And stone would not burn. For the little girl next door had an oven built of stone and in it she baked mud pies. Sometimes he helped her. Not because he cared about mud pies, but because Mother said he ought to be polite. And besides she was such a very little girl. And he knew that the stones got very hot. But they would not burn.

Coal, it seemed, was different. He had watched Daddy shoveling it into the furnace last winter, and he knew what a hot fire it made. He wondered where it came from. It came from somewhere on the cars for he had heard Daddy talk about a carload of coal. But where, he wondered.

He asked Mother but she was busy beating eggs for the pudding she would not let Nora make. So she just said, "From the mines, dear." And went on beating eggs.

Now Ted wondered what "mines" meant. So that night he asked Daddy. And Daddy told him a long

story. He could not remember it all but this much he did remember.

A great many years ago the earth was covered with plants and tall grasses and trees. Perhaps the trees looked a little like those along the trout stream where they had fished. But they were much older. And there were no people living on the earth then. Not even Indians.

And after that the rivers spread out over the land in some places, and covered the plants and trees. And then the sand washed down by the rivers spread out, too, and left the plants and trees buried in the earth. Then they hardened into what we call coal.

No one knew that the coal was there until many years later when men began to dig it out and use it to burn instead of wood. They were still digging it in what they called "mines."

This set Ted to thinking. You could light the gas stove and have a fire. You could gather wood and make a fire. Or you could heap up coal and keep a fire all winter in your furnace. And how glad you were to have a fire in winter.

And yet when summer came you wanted no fire at all. Indeed if you went outdoors and stood there bare-headed you were glad to hurry back into the house to get cool. It was very funny.

"Daddy," said he, "wouldn't it be fine if we could put the sunshine into a bottle in the summer when it's too hot, and save it to use in the winter when it's too cold? Then we wouldn't need to buy coal."

"Wouldn't it?" said Daddy. "In fact that is such a good idea that nature thought of it long before we did. Only we don't always know where to look for the bottles."

Ted sat up very straight. "Do you know where to look for them, Daddy?" he cried. "Could I find any, do you think?"

"You found a good many in the woods, didn't you, the day we went fishing?"

"In the woods? Bottles? Why no, Daddy, Truly I didn't see a single one." He wondered what Daddy could be thinking of.

"Didn't you help us make a fire?"

"Yes, I gathered all the wood." He was rather proud of this.

"I picked up a lot of twigs and branches, but I didn't see any bottles."

"The twigs and branches were the bottles—bottles of sunshine."

Ted's eyes grew big. What could Daddy mean?

"Listen, Ted. All the heat we have comes from the sun. The earth stores it up for us. The trees hold the sunshine and when we cut them down we can build a fire

with them. Coal, which is made of buried trees, holds the sunshine and we make a fire of it. Gas, which we use in our gas stove, is just a part of the sunshine which the coal has stored up for us. All fire is bottled sunshine. There is no heat which did not come at first from the sun.

This seemed very strange to Ted. "Gee, it must be hot up there," he said. "We wouldn't want to go very close to it, would we, Daddy? How close to it could we get, do you think, if we could fly up into the sky?"

"Well," said Daddy, smiling, "the sun is more than ninety millions of miles away. So we wouldn't run much risk of touching it if we did fly up into the sky."

"Ninety millions of miles!" said Ted. Ninety was nine times as many fingers as there are on both hands. He had learned that in school. And a million miles was all the miles there are. At least that is what he and Uncle Bob thought. And the sun was that far away. It seemed farther than anything could be. So he just stopped thinking about it.

## CHAPTER III

Daddy had gone to the office the next morning and Nora was hanging up tea-towels in the yard when Mother quickly set down the bowl of roses she had picked and hurried into the kitchen. There was a queer smell in the air and a crackling sound.

"Nora," she called, "your tea-kettle has boiled dry."

Nora came running from the yard. She picked up the kettle just as Mother turned out the gas. They both looked at it. It was not hurt. But it still crackled and there was still a queer smell about it.

"Now think o' that," said Nora. "And me only gone a minute."

"What happened, Mother?" asked Ted.

"The water boiled away."

"Away where?"

"Why, away, dear. It just boiled away."

That was one queer thing about Mother. She never answered questions like Daddy. She just kept saying one thing over again.

"Nora," said Ted, when Mother had gone back to her roses, "where does water go to when it boils away?"

"Sure, darlin' an' I don't know. Into the air, I guess. Did you never see steam on the windys when I'd be doin' a bit o' washing?"

"No," said Ted. "What is steam?"

"Och, darlin', go ask yer Daddy. Nora's busy."

Ted wanted to ask Daddy, but he had to wait until evening to do that. So instead he walked over to the stove again when Nora had left the room and began to watch the kettle.

Nora had filled it with fresh water and set it once more over the fire. It made a rumbling sound inside. After awhile a little white cloud came out of the spout. This must be what Nora called steam.

He took a holder and lifted the lid. There was no steam inside the kettle, just water boiling. And there was no steam in the room. Where had it come from? Where did it go?

He looked more closely. Just at the mouth of the spout was a clear space, before the white cloud began. There was no steam there. He wondered why. He put his finger into the clear space to find out how it felt.

Then he must have screamed. For the next instant Nora came flying in from the yard and Mother from the living-room.

"Bless the child," cried Nora, "he's burned himself."

And then Mother was holding him in her arms and Nora was hunting the baking-soda. When she found it they tied up his finger and it did not burn quite so much. But he did not go near the stove again.

That night with a clean, white bandage on his finger, he sat on Daddy's knee and told him about it. "But there wasn't any steam," he said, "where I put my finger."

Daddy smiled. "Not that you could see," he said. "Water is a queer thing. Sometimes we can see it. Sometimes we can't. Steam is just water in one of its forms. There are other forms too. Some day you must learn about them."

"Tell me now," he begged. "Tell me about steam, anyway."

"Well," said Daddy, "when water boils it does not stay in the kettle. It boils away."

"That's what Mother said. But where does it go?"

"Into the air. That is why you saw a cloud near the spout of the kettle. But the cloud does not form at once. Just at the mouth of the spout is a clear space before the cloud forms. This clear space is pure steam or vapor. It is as hot as boiling water. You found that out when you put your finger there. But because it is pure steam we cannot see it.

"When it reaches cooler air it is chilled and shrinks into a cloud. This floats in the dry air of the kitchen until it melts, just as sugar melts if you put it in water. When it melts we cannot see it. We call it gas or vapor. And because we cannot see it we say it is invisible."

"In-vis-i-ble," repeated Ted.

"Invisible?" said Uncle Bob, coming into the room at that moment. "What do you know about a big word like that?"

"I know what it means," said Ted, proudly. "A thing is invisible when you cannot see it."

"Like what?" asked Daddy. "Tell Uncle Bob what happened to you this morning."

"I burned my finger in the steam from the tea-kettle. I couldn't see it. But—but I could feel it.

"I'll bet you could," said Uncle Bob.

And just then dinner was ready and they all went out to the table.

## CHAPTER IV

It was not until after dinner that Ted began thinking again about steam. Uncle Bob had dropped a pile of books upon the table when he came in. They had pictures in them. Ted thought they were queer pictures, as he turned the leaves.

“What are they, Uncle Bob?” he asked.

“Steam engines, old man.”

“Steam engines?”

“Yes. Didn’t you know that steam could drive an engine?”

“No,” said Ted. “What kind of engine?”

“A good many kinds. Steam can pull a train of cars. Steam can run a factory.”

“I don’t see how,” said Ted. He was thinking of Nora’s tea-kettle. It hadn’t seemed able to do anything except burn his fingers.

“Well,” said Uncle Bob, “you find out how when you go to college and study these books. Some day I’ll take you to the engineering building and show you the big engines there. We have to learn how they are put together.”

“How big are they?”

“Big enough, but not so big as the ones they really use —on steamships, for instance.”

“How big are they?”

Uncle Bob laughed, caught Ted round the waist and tossed him up to the ceiling, then set him down suddenly on a corner of the mantel.

"Listen, old man," he said. "Some day you and I will board an ocean liner and find out. Do you know they build ships as long as a city block, that can carry thousands of people?"

"Gee," said Ted, "I shouldn't think there would be steam enough in all the world to run them."

"How much steam is there in all the world, Uncle Bob?" he asked, suddenly.

Again Uncle Bob laughed.

"Once upon a time," he said, "the whole world was covered with steam."

"Covered with steam? How could people live without getting burned?"

"There were no people."

"Not even Indians?"

"Not even Indians."

"Then if there weren't any people, how does anybody know anything about it?"

Uncle Bob set Ted down suddenly on the floor. He laughed more than ever.

"My child," he said, "you will be a joy to your teachers as you grow up."

Then, "Listen, Ted. This earth we live on was once a part of the sun."

Ted thought that was a mistake. "I don't see," he said, "how it could get up there."

"It didn't get up there. It was there. It came from there."

Ted still looked doubtful.

"Do you remember," said Uncle Bob, "when you and Mother were making candy the other day, how Mother took the spoon out and twirled it so fast that some of the candy flew off and stuck fast to the stove?"

"Well, that is what happened to the sun. It was whirling so fast that a piece of it flew off and became the earth. And because the sun was very hot, the earth was very hot too. And because the sun was whirling so fast, the earth kept on whirling too."

"Couldn't it stop?"

"No, it hasn't stopped yet. And because it was so hot there could be no water on it, only steam. It was covered with steam which rose in thick clouds. When the clouds reached the cooler air above they turned into water which fell again."

"The earth gradually cooled off, however, by its constant turning, just as your spoonful of candy cooled when you waved it in the air. And so the steam, or vapor, hanging over it was also cooled until it became water and covered the earth like a great sea."

"As long as the earth was still hot, though, this water again boiled and again rose and fell in a great shower of

rain. Thus rising and falling by turns, it filled the cracks and low places in the earth's crust, and formed rivers and lakes."

"Gee, Uncle Bob, that must have been some rain. How long did it last?"

"Nobody knows. But it must have been many thousands of years. And even when the earth was cool and the streams could flow, this rising and falling of the water did not stop."

"Why not?"

"Because the heat of the sun still kept changing water into vapor."

"How long did it do that?"

"Always. It is still doing it. Water still rises and becomes vapor. Then reaching cooler air it falls as rain."

"Now?"

"Right now."

"But I never saw it."

"Of course not. Didn't you tell me that vapor was—?"

"Invisible," shouted Ted.

"And that means?"

"We cannot see it."

"But you can see it sometimes, Ted. Some of it does not fall at once but stays in the air as clouds. And sometimes these clouds, pushed by the wind, touch the tops of mountains and there form dew or fog or snow."

"But snow isn't water."

"It certainly is. And so is ice."

Ted took a minute to think about this. He knew that ice melted very fast if you held it in your hand. And then it was water, to be sure.

"Ice is water in a solid form. Water is water in a liquid form. Steam is water in the form of gas or vapor. Can you remember that? Solid, liquid, gas or vapor."

"Solid, liquid, gas or vapor," repeated Ted. It was as hard to remember as "invisible."

"Tell me some more about water," he begged.

"Water?" Uncle Bob rose from his chair, tucked two fingers between the buttons of his vest and puffed up his chest the way the dean of the college always did when he was going to make a speech.

Ted laughed. He knew Uncle Bob was going to be funny.

"Water," said Uncle Bob, "is the most useful thing we have. Wherever and in whatever form it reaches the earth, the earth welcomes it. It drinks it in. It holds it like a sponge. And so the hidden places are filled with it. It bubbles up as springs in the mountain. It flows through ravines in streams. These streams join each other and form rivers, which flow on to the sea.

"These rivers carry sand and earth along with them and thus build up new ground. They are always busy tearing down or building up and bringing life to plants and animals.

"When they reach the ocean they are lost in its depths. But not for long. For nothing in nature is ever lost. The sun shining on the sea soon drinks up these drops of water again, and again scatters them over the earth. So that the ocean constantly receives water flowing into it from the land, and as constantly gives it back again into the air. This goes on without stopping and will go on forever.

"Nothing that we see or touch is ever destroyed. It may change its form; it may be separated into its parts; but it is still there. A plant in the autumn is killed by the frost; its leaves dry up and fall upon the ground. But the ground is so much the richer. And in springtime it will give back more beautiful flowers. A tree is cut down and burned, but the smoke of it rises into the sky. Just so all the water in the plant and in the tree is saved and goes up to mingle with the clouds.

"Go out into the garden some June morning and see the dew sparkling drop by drop on the roses. Those same drops may have formed the snow crunching under the tread of the Polar bear, or have slaked the thirst of a tiger on the burning sands of Africa. They may have furnished drink for the first living man; they may furnish drink again for our great-great-grandchildren. We may even meet them again ourselves in the ice over which we skate in December.

"Water is one of the commonest things we know. It is everywhere. We could not do without it. It causes

the earth to be fruitful and give us food. It gives moisture to the air, without which we could not breathe. It is a part of all animals, all vegetables, and is even found in minerals. It flows across the earth finding its way into everything.

"It is our most wholesome drink. Indeed it is the chief part of everything we drink. We sail our boats on it. By it all parts of the country are brought together.

"It is the willing slave of man. In the form of steam, it gives us power. We use it to run our factories, to drive our trains. Thus it helps to give us all we have to eat or wear. It takes us everywhere. It helps to make of all the world one great family.

"Thus as solid, liquid, or gas, it is our greatest friend. Let us go on then and find out what water is, what it is made of, and what it can do for us?"

"Do you mean that, Uncle Bob?"

"Mean what?"

"Will you really tell me all about water some day?"

"Some day, perhaps."

## CHAPTER V

The little girl next door had set three of her dolls in a row along the hedge. It was a low hedge between the two yards. Ted could talk to the little girl over it. He wondered what the dolls were doing there. He took no interest in dolls but still he wondered.

He walked along the hedge until he came to the opening just where the hollyhocks began. There was not supposed to be an opening there. But that was where he always went when he had something to show to the little girl. And when you push very close to a hedge a good many times, and some one in a pink bonnet pushes very close to you on the other side, to see what you have to show, there soon comes to be an opening which is nobody's fault.

Ted walked to this opening and stepped through to see what the dolls were doing. He found out. They were having a party. There was a table in front of them with a white cloth on it. And there was toy dishes and a vase of flowers in the middle, just as Mother always put flowers on the table.

And the little girl was coming from the house with something in her hand. She wore a pink bonnet as usual and also a pink dress. But it was a round kind of dress that stood out away from her and it had ruffles. It was not at all like the rompers she usually wore when she played in the yard.

There was something queer about her eyes too. It looked as if she had tears on the ends of her eyelashes. And she talked in jerks.

"Mother—went away," she said. "She dressed me—before—she went. So I could—go driving—with Daddy—after lunch."

"That's nice," said Ted.

"And she said—I could have—a party—but Jane—won't let me—have *anything* to eat." Her voice went up in the air all of a sudden—something like the way a cat sounds when you step on its tail.

Ted jumped. "Don't," he cried. "Don't do that."

It made him feel like hitting something. Anyway it was silly to cry.

"You don't have to have things to eat to have a party," he told her.

"Yes, you do," she said, looking at him with very wet eyes.

"Not real things, I mean."

"But I want real things."

"Make-believe things are just as good," he said.

She still looked at him.

"Make-believe things are even better," he went on, getting more and more in earnest. They never give you the—the stomach-ache."

"Come on," he said, "let's get some sand—and water—and build a fire—and make some mud pies."

"Will you?" she said and began jumping up and down.  
"Sure." And they went to work in a great hurry.

They piled up sand and brought water from the house in a tin-cup. Then they gathered some twigs from the dead branches underneath the apple-tree. Paper they got from the back porch, where Jane had laid a pile of newspapers.

They still needed matches. They watched their chance to get these. For they would not ask Jane for a thing. Not after she had said they could not have real things to eat.

It was some time before they could get to the matches, for Jane was scraping potatoes in the kitchen. After a while, however, she came into the yard and began talking to Nora across the hedge.

Nora had just come out of the house with a pail of water and a broom. She was going to scrub the walk. It was a good time to get the matches while Nora and Jane were talking.

The little girl jumped up and down as the paper began to burn. At first the fire curled slowly around the edges, then suddenly it shot up into the air. The next minute the pink dress that stood out all around was blazing too, and the little girl screamed and began to run.

"Howly mother!" screamed Jane, as the child ran towards her. The next minute Nora was over the hedge with her pail of water. She emptied it in one breath over the pink dress.

The little girl stood gasping and shivering from her cold bath. But the fire was out.

After that Jane went to the telephone, and soon the doctor was there and the little girl's Daddy. Her mother came much later because she had to come on the train.

By the time she got there, the little girl was feeling quite comfortable and the doctor said her burns would soon be well. But she looked so funny when they carried her out on the porch, with her fat little legs all tied up in something white.

By the next day she grew tired of sitting on her own porch and she could not run and play. So Ted begged her mother to let her come over to their porch for a change.

Soon after they had carried her over and placed her in a comfortable chair, her father and Ted's father came home on the same car and were very much surprised to find her there.

"Tell us a story, Daddy," teased Ted, for he too found it hard to sit still on the porch when he wanted to run and play.

"Well," said Daddy, "a great many years ago there were people living on the earth called Greeks."

"I know one," said the little girl. "Daddy goes to his place sometimes for lunch. I went with him once."

"Well, yes," said Daddy, "I know him too. But these people were a little different. We call them ancient Greeks."

"And they thought a great deal about a great many things. And they believed that there was just four things from which everything else came, earth, air, fire, and water. And they thought that fire and water were as different as could be, because they could use water to put out fire."

"Just like Nora put out me," said the little girl.

"Exactly," said Daddy.

"But after a long while, people found out that water was not so different from fire after all. That was after they learned to divide it into its parts."

"Its parts?" said Ted.

"Yes," said Daddy. "When you go to college you will learn how to divide water into two parts. One part will burn. The other part helps other things to burn. We use some of it to light our cities. Some of it we breathe in the air."

Ted looked very doubtful. "We can't breath water," he said.

"No, and we can't burn water. Not until we divide it into the two parts, or gases, of which it is made."

"What are their names?" asked Ted.

"You couldn't remember if I told you."

"Yes, I could. Anyway, I could try."

Daddy smiled. "Oxygen," he said.

"Ox-y-gen," repeated Ted.

"And hydrogen."

"Hy-dro-gen."

"And part of it will burn."

"Isn't that funny?" said Ted, turning to the little girl.

"Would you think water could burn?"

But there was no answer, the little girl had gone to sleep.

## CHAPTER VI

Ted had a cup of water which he poured slowly to the ground. The dolls were having their first party since the little girl next door had gotten over her burns. But there was no fire and no mud pies. Ted had stepped through the opening in the hedge to see.

There were real things, though, to eat, cookies and a pitcher of milk. The little girl's mother had said "no milk" at first. And then afterward she remembered an extra bottle on the ice and sent Jane down to the party under the apple tree with the pitcher. That was why Ted, who had been invited to the party, was pouring the water out of his cup.

It was a silver cup with letters marked on it, a very pretty cup, in fact, but it was not the cup he was looking at so closely. It was the drops of water falling from it to the ground. Why were they round, he wondered.

If he poured the water a little faster it fell in a stream, but the stream was round too. If he stood up on a chair it fell first in a stream, then in drops. It struck the earth with a thud too, as if it fell faster the farther it went.

"Well, little Sir Isaac," said a voice near by, "studying the force of gravity?"

It was Daddy, home early from the office.

"Gravity?" said Ted. "What is gravity?"

"That is what Sir Isaac wondered too," said Daddy.

"And who was Sir Isaac?" Ted went on.

The little girl looked up gravely from her dolls. Ted's Daddy had seated himself in one of the small chairs with his long legs stuck out in front of him. It was such a little chair for such a big man. But Ted's Daddy seemed to be thinking about nothing but Sir Isaac.

"Sir Isaac Newton," he said, "lived a good many years ago. He watched the things that went on around him and wondered about them."

"He noticed that water fell in drops that were almost round. That they were about the shape of apples, in fact, a little flat on the top and on the bottom. And that they fell faster the nearer they got to the ground.

"One day he was lying under an apple tree and saw an apple drop. He wondered what made it drop. He went on wondering for a long time. At last he thought he had found out.

"'Ha,' he said, 'I think the earth must pull the apple down, but if that is so, then the apple must pull the earth up. Of course, it can't pull the earth very far because the earth is so much bigger than the apple.'

"This was found to be so. Sir Isaac said the earth attracts the apple and the apple attracts the earth, so they come together. But the apple is small and it moves so much farther than the earth, that the earth does not seem to move at all.

"Now if you hang an apple on a string it stays there all the time and the string is quite straight. I suppose it must be pulling on that string all the time, and trying to get to the earth. If you don't think so cut the string with a pair of scissors and see. This funny thing that makes the apple fall, Sir Isaac called gravity."

Daddy got up after that and stretched his long legs. And the little girl felt relieved about the chair. The door clicked behind him as he went into the house.

Just after that there came another sound that made both Ted and the little girl look up into the sky. It was a distant rumble. And the sky was growing dark.

They began to gather up the toy dishes and the dolls. But before they could finish, a big drop of rain fell plump on the little girl's nose. Ted laughed to see how surprised she looked.

Then more drops fell, on their heads and hands and all around them. They ran for the porch. By the time they reached it, a million such drops were falling all around them.

They fell in streams, in bucketsfull, it seemed to Ted. They stood on the porch and watched them. Then the rain began to drive in and they went into the house.

Against the window pane it came dashing. It seemed determined to get in. Since it could not get in, it ran down in little streams, which joined each other and became big streams.

They wondered at the force of it outside. Where it struck the ground it made holes. It dashed so hard it bounced and threw mud against the porch steps. They laughed as they watched it. But Ted was thinking too.

"Where does it all come from?" asked the little girl, clapping her hands.

"Out of the sky," said Ted, still thinking.

When he first poured the water out of his cup slowly, it fell in drops that hardly disturbed the dust. When he stood up in a chair it fell harder. But it would take a very high chair indeed to make it fall as hard as this.

He looked up into the sky. He could not see the sky. He could only see rain. It was a very big cupful of water that was falling now. One could not see to the edge of it.

Yet it seemed to be the same thing. Water falling from a height. His cupful of water was a small shower. This drenching rain was a big cupful of water. And it fell faster and harder the farther it came.

He had watched rain before. Sometimes it came slowly and gently. You hardly knew when it began. That kind of rain fell on a gray day when it was cloudy all around.

But to-day had been a clear day or there would have been no party for the dolls. The rain had come suddenly. It must have come from very far up in the sky, where they could not see it coming. It must be because it came so far that it fell so hard.

The next minute something rattled against the window pane that was not rain. It sounded like pebbles. It looked like pebbles, too, as it lay scattered on the window sill.

Ted opened the window just a little and gathered some of it in. It melted in his hand. This was very strange.

It seemed to be ice, just like the ice in the ice-box, only not the same shape. For when Nora took the ice-pick and broke that, it flew into splinters. This was not splintered ice but round ice.

It was round like pebbles, or apples, or—could it be—raindrops? He almost jumped. Maybe it was. Maybe it was frozen raindrops. He must ask Daddy.

He did not have long to wait. For the rain had stopped dashing now, and Daddy had stepped over the railing between the two porches and had come to take him home.

“Daddy,” he cried, “look, look,” and showed him the pebbles on the window sill.

“Yes, I see,” said Daddy. “Hail, isn’t it. I heard it too.”

“Hail?” said Ted. “What is hail?”

“Frozen raindrops.”

Ted fairly danced. He had guessed right.

“But what made them freeze?”

“A cold wind. You know the higher up you go in the air, the colder it gets. And sometimes just when

the raindrops are falling a specially cold wind cuts across and freezes them right where they are. Then they fall as ice pebbles instead of raindrops. And we call these ice pebbles hail."

"Oh, look," cried the little girl. "The sun is coming out." And surely enough it was.

The drops on the window panes still joined together and formed streams. The streams still ran along the sills and dropped to the ground. There were deep puddles of water on the walk where the rain had dashed.

But the sun had come out and was making diamonds of the drops and gold of the pools of water. And out under the apple tree where the party had been it was wet but shining.

"Why did it have to rain?" pouted the little girl.

Ted shook his head.

"I don't see where rain comes from anyway," she went on.

"From the sky," repeated Ted.

"Oh, of course I know that," she cried. "You said that before. But what made it come down on our heads?"

"Gravity," said Ted.

## CHAPTER VII

It was a bright summer morning. Uncle Bob strolled into the dining-room humming a tune. Daddy had gone to the office and Ted was just finishing his breakfast.

Nora brought a pitcher of milk from the ice and set it on the table for Uncle Bob's cereal. It was a silver pitcher, almost as bright as the sunshine itself. Ted could see his face in it—a funny puffed out face where the pitcher was rounded—as he sat across the table from Uncle Bob.

A few minutes later he looked at the pitcher again. He could not see his face at all now. The pitcher was covered all over with a mist. He wondered why.

He reached across and ran his finger over its smooth side. It was cold and wet. There was water on his finger which he had brushed off the pitcher. He could not understand it. Surely the pitcher did not leak. If it had, it would have leaked milk and not water.

He looked at Uncle Bob, who was eating his breakfast as if he had no thought of anything else in the world. In reality Uncle Bob was thinking very hard about a trip he was going to take later in the summer. So when Ted said, "What makes the pitcher wet?" he answered "The—er—what?"

"The pitcher."

"The pitcher—what?"

"What makes the pitcher wet?" repeated Ted.

"Oh," said Uncle Bob, as if he had just waked up, "cold things always sweat in hot weather. It's—er—condensation, you know." Which meant nothing at all to Ted. So he climbed down from the table and started for the door.

"People don't sweat when they're cold," he said. "They sweat when they're hot."

At that Uncle Bob laughed and his mind came all the way back from that camp where he was going next month.

"Listen, youngster," he said, "we'll go outdoors and talk it over."

He swung Ted up to his shoulder, ran with him down the steps from the porch, then set him down suddenly on the gravel walk.

"Don't go on the grass, dear," called a voice from above.. It was Mother shaking something out of an upstairs window.

They both looked up.

"Keep on the walk, both of you," she repeated. "The grass is wet."

Uncle Bob shouted. He was Mother's youngest brother, and he always said she treated him as if he were just Ted's age.

"All right, sister," he agreed. "We'll sit here on the lowest step like the pair of good children that we are, and keep our precious feet on the walk. Will that do?"

"Yes," she laughed. "That will do."

"Why is the grass wet?" asked Ted. It didn't rain last night, did it?"

"Dew," said Uncle Bob.

"Dew?" repeated Ted. "What is that?"

"Dew is what you saw on the milk pitcher."

Ted looked doubtful. There was a twinkle in Uncle Bob's eye just as there always was when he was teasing someone.

"No, it isn't," said Ted. "That wasn't dew. You said it was con-con—"

"Condensation," said Uncle Bob. "Well, so is dew."

"Listen, child," he said, "and I'll tell you about it. What became of the water that boiled out of the tea kettle the day you burned your finger?"

"It went into the air."

"Do you suppose it stayed there?"

Ted did not know.

"Well, some of it did. There is always water in the air we breathe. We could not live without it."

"The first animals that ever lived, lived in water. And we are all of us water animals, more or less, still. Our bodies are largely made of it. We have bones to give us shape, but three-fourths of the body is water. So we must both drink water and breathe water to keep well."

"This water forms our blood and flows through every part of us. It washes us out, as it were, because when we are through with it we breathe it out again. Hold

a mirror before your face some frosty morning and watch the mist gather on it just as it gathered on the pitcher at the breakfast table. That is water that we are done with, so we breathe it out into the air again.

"We also throw it off from our skin. We see it stand in drops of sweat on our faces. As you said just now, people sweat when they are hot. And that is a good thing, because the sweating cools us off. We could not stand warm weather without it."

"We also like to drink a great deal of water when we are warm. It helps too to cool us off. And the air is something like ourselves. The hotter it is the more water it can drink. But when it cools off it breathes out the water again in a mist such as you saw on the pitcher. When this happens we say it condenses. Can you remember that?"

"Condenses," said Ted.

"What does water do when it goes up in the air?"

Ted shook his head.

"E-vap—" prompted Uncle Bob.

"Evaporates," shouted Ted.

"What does it do when it forms again in drops out of the air?"

"Condenses."

"Right-o," said Uncle Bob.

"And when does water evaporate?" he went on.

"When—when—it is hot," said Ted.

"Yes. And when does it condense?"

"When it is cold." And then Ted turned a hand-spring on the gravel walk. He was so proud of what he had learned.

The gravel walk was hot to the touch. The sun was now beating down on it. But the grass beside it was wet and cool. Ted wondered why.

"You haven't told me yet," he said, "why the grass is wet."

"Yes, I have," teased Uncle Bob. "It is wet with dew."

"But the walk isn't wet. Why not?"

"Lesson number two," said Uncle Bob. He stretched up his arms and pretended to be very tired.

Then he said, "Would you like to see something through the microscope?"

Ted jumped to his feet. Microscope was a big word but he knew what it meant. It was the name of something Uncle Bob had brought home from his study room at college when the term ended. It was a wonderful glass. Anything you put under it grew so big that you could see everything about it plainly. You could even see things in it that you never knew were there. Your own thumb-nail was as full of ridges as a plowed field. He ran to get the glass.

## CHAPTER VIII

Uncle Bob was looking closely at something near the gate when Ted came back with the microscope. It was a spider's web, beautifully formed and sparkling with dew. He lifted it carefully. As it came free they saw that the grass beneath it was dry. Ted wondered why.

Then Uncle Bob told him.

"If you throw a pebble in the water," he said, "you see waves moving away from where the pebble fell."

Ted nodded. He had often seen them.

"Well just so there are waves in the air. We call them heat waves. They come down from the sun. And so during the day, when the sun shines the earth stores up heat. But at night when the sun has gone down, these heat waves go up again. They are always moving one way or the other.

"Now if there were nothing between us and the sun, the earth would get so hot during the day that we could not walk on it. And so cold at night that the plants would freeze and die. But fortunately we have the air between us and the sun. And the air is partly made up of water in the form of vapor. This vapor acts like a tent over us. It catches some of the heat waves as they come down and keeps the earth from getting too hot. It also catches some of them as they go up from the earth at night and keeps it from getting too cold.

"It is because of this vapor tent that we have dew. The grass blades, being very thin, lose their heat faster than they can draw it out of the earth. So they become cold. And the vapor just above them is chilled by touching them. Being chilled, it forms in drops of water on the leaves.

"The cold pitcher on the breakfast table and the cold leaves of a summer night do the same thing. They chill the vapor in the air into a mist of fine water drops.

"But suppose you spread something over the grass, your handkerchief, perhaps. There will be no dew on the grass under that even though there is dew all around. Why?

"Because that thin piece of muslin stops the heat waves as they rise and keeps the grass from getting cold enough to draw the water out of the air.

"The spider's web we lifted did the same thing. You saw plenty of dew-drops on the web but none on the grass beneath. For even a spider's web is strong enough to shut in the heat waves and keep the grass blades warm."

"But Uncle Bob, why isn't there dew on the gravel walk? Nobody spread a handkerchief on that."

"The gravel walk is very different from a blade of grass. Gravel can draw up heat from the earth as fast as it gives it out, so it never gets cold enough to draw water out of the air. That is one of the ways in which na-

ture takes care of things. The grass, which needs water, can draw it out of the air. The gravel walk, which does not need water, cannot draw it out.

"There is another trick which nature has. On a cloudy night, when there is a chance of rain, there is little or no dew even on the grass. This is because the clouds keep down the heat waves so that the grass does not become cold enough to form dew.

"But after a hot dry day, when the plants are thirsty and there is small hope of rain, they have the best possible chance of drinking the dew from the air.

"In some hot countries there is rain only at certain times in the year. All the rest of the year the skies are cloudless and the rain never falls. If it were not for dew, every green thing would dry up and die. But because the air is so hot and dry and there are no clouds, the dew forms thickly enough to take the place of rain. In this way nature takes care of all plant life.

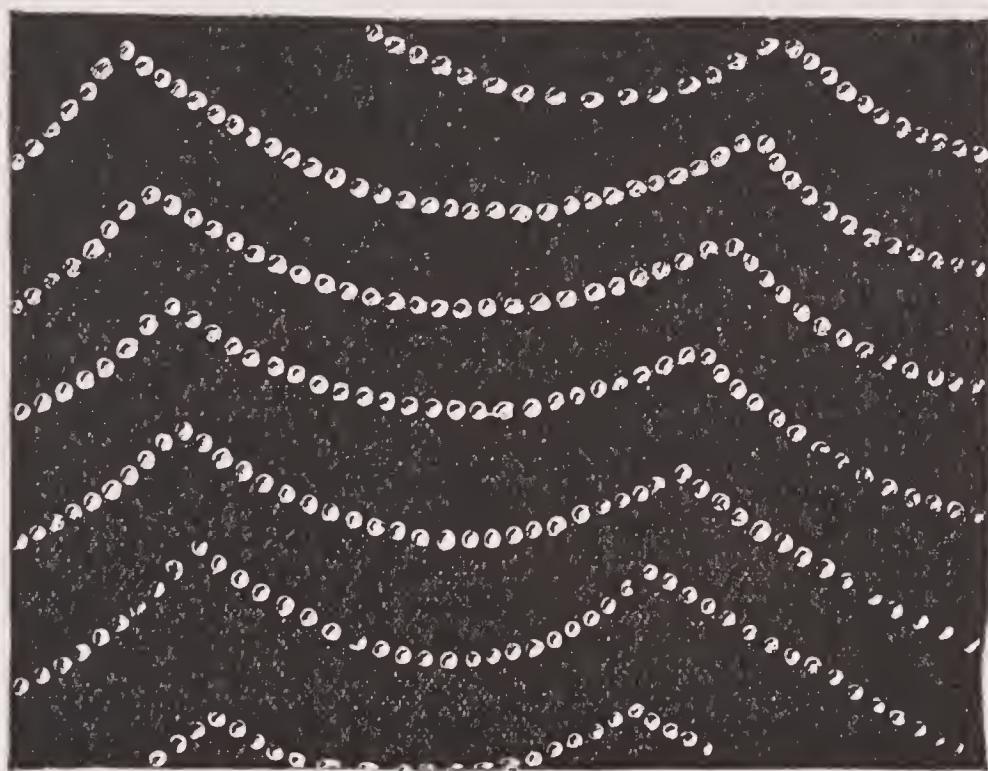
Only on the deserts covered with sand there is no dew. For sand is like our gravel walk, only finer. And everywhere the air touches it, it heats the air and makes the water rise again instead of condensing in the form of dew.

"Now, then," finished Uncle Bob, "suppose we take the microscope and see what we can find."

They had a wonderful walk that morning. They went down the lane that led away from the street. And there were all kinds of weeds growing. They looked at many

of them under the microscope. They learned much about dewdrops and the way they cling to different stems and leaves.

They found first of all that a dewdrop is like a mirror. Just as Ted had seen his face—all puffed out—in the rounded side of the silver pitcher, so one could see a cloud in the sky—upside down in a dewdrop.



Spider's Web Magnified

Then they looked at a spider's web. For some strange reason, no one knows why, the dew had gathered only on the cross-wise threads, not on the up-and-down ones. And every drop was the same size, so that each thread looked like a string of pearls, as even as the pearl necklace in Mother's jewel-box.

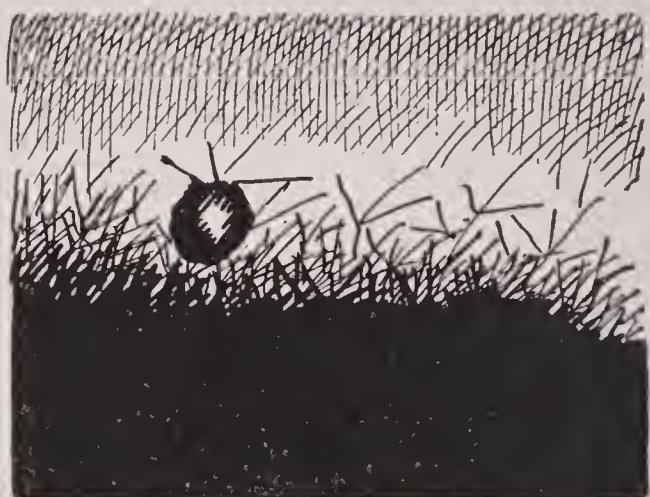


Caterpillar

A caterpillar, who must have slept out all night, had a regular shower bath of dew on his furry back.

Among plants, a mullein leaf, which was almost as furry as the caterpillar, held a number of large drops.

Sharp-pointed grasses had their dew-drops collected in a row along one or both edges. On the top would be a large drop, along the edges a regular row of little ones like beads. When the large drop was



Mullein Leaf with Dew Drop Magnified

ready to fall it would roll along the edge, gathering all the little drops as it went until it fell in one heavy drop into the earth to water the roots of the plant.

Leaves too gathered dew, not only on the flat part but on the edge too. And as all leaves were not the same shape, there was difference in the way the dew formed.



Strawberry Leaves with Dew Drops

A strawberry leaf, sharp-pointed around the edges, had dew not only on its flat part. It had also a big dew-drop in each nick around the edge.

The stems of many plants were hairy or furry like the mullein leaf. They also had dewdrops all the way down.

One thing Ted noticed was that even the weeds with their tiny flowers smelled sweet when they brushed past

them. Uncle Bob said the dew did this too. That all flowers were sweeter with the dew on them.

When they got home Nora was on the back porch freezing ice cream for dinner. Ted had so much to tell her about the dewdrops that he almost forgot to notice what she was doing.

"Then he said, "Oh, goody, goody, ice-cream."

And then he stopped short and looked at the freezer. There was frost on it, regular frost like the kind you could see in winter on the window panes.

"Uncle Bob," he cried, "what makes frost on the freezer?"

Uncle Bob dropped down on the porch and clapped both hands over his ears. He pretended to be deaf. You see he wanted to go on thinking about that camping trip.

"What makes questions on a little boy's tongue?" he said.

"Well, but Uncle Bob, what *does* make frost in the summertime?"

"The same thing that makes dew."

Ted looked blank.

"What did I tell you? Con-den-"

"Condensation," shouted Ted.

"Right-o," said Uncle Bob.

"But why does it make frost instead of dew?"

Uncle Bob sat up straight. He took out the two fingers he had stuffed into his ears.

"Well, child," he said, "water can be very hot or very cold. Or it can be anywhere in between. Now when the air with water in it cools down to a certain point, it forms dew. So we call this point the dew point. But if it gets still lower it forms not dew but frost. For frost is frozen dew."

"Now the ice and salt that Nora is using to freeze the ice-cream make the air around the freezer very cold, so that it condenses into frost and not dew. It is the same kind of frost you will see next October on the garden. Remind me of it then and I will tell you about frost crystals."

"But Uncle Bob—"

"Not another word, old man. Next October, I said, not now."

"But—"

"October, I said." And Uncle Bob went into the house singing, "When the frost is on the pumpkin and—"

The door banged and Ted could hear nothing more.

## CHAPTER IX

"I can see a bear—and a mountain—and an *awful* big giant," said Ted gazing up into the sky.

"Now the moutain is melting. And the bear is all gone. No. he's turned into a horse. And the giant—oh, look, the giant's reaching down. See him there?"

"No," said the little girl. "It just looks like white-of-egg to me, when Jane beats it up for a pudding."

Ted looked disgusted. There were so many things the little girl could not see. And why was she forever fooling with that doll?

He blinked as he looked at the green trees around them. They were restful to look at after the sky.

When he looked up again the giant had melted into little flecks of foam under the horse—or was it a camel? That was the worst of it. It was forever changing into something else while you looked.

Perhaps it did look like white-of-egg after all, only a wonderful kind of white-of-egg, tinged at the edges with pink and silver and gold. And beaten in a big blue bowl that fitted right down over the earth.

"Or soapsuds," the little girl said next.

"Gee," said Ted, "if we could bring it down here couldn't we blow a lot of bubbles?"

Somebody up in the sky seemed to be blowing soap bubbles now. Ted could see them—floating, floating. That was one strange thing about clouds. They not only

changed their shape, but they always kept moving. Ted wondered why.

In fact he had often looked at the clouds and wondered at them. They looked so different at different times of day. In the morning they lay like straight bands across the sky. Sometimes the bands were not straight but curly. And now in the middle of the afternoon they were piled in heaps. You felt as if you could reach up, with a long enough spoon, and scrape off one cloud from another behind it. And then there was a very thick black cloud that came just before a shower.

It was not very long before he saw just such a dark cloud gathering. The clouds that looked like white-of-egg or soapsuds thinned out and floated off faster than before. And the dark cloud seemed to be chasing them. But it did not chase them very far. For after a few drops of rain, which drove the children into the house, the sun came out again.

It shone right down between the clouds. Indeed it shone down even while the rain was falling. And then a wonderful thing happened. Right around the blue bowl, where it fitted down into the tree-tops, was a beautiful band of color, red and blue and green, all shading into each other. The children danced for joy. "A rainbow," shouted Ted. "A rainbow!"

And just then Daddy came home and they showed it to him.

"What makes a rainbow?" asked Ted.

"And aren't clouds made of white-of-egg?" said the little girl.

"My, my," said Daddy. "One at a time, please."

And then he got a book with pictures in it and began to tell them about the clouds.

"What makes a cloud?" he asked first of all.

No one answered.

"You know, Ted," he said. "What happened when the water boiled out of the kettle?"

"It—it made a cloud," answered Ted.

"Precisely. And what happened in the kitchen, happens outdoors and everywhere.

"There is always vapor—that is water—in the air. Because when the heat of the sun meets water anywhere, it changes it into invisible vapor. This vapor rises rapidly into the sky.

"Now hot air can hold more water than cold air. But fortunately no kind of air can keep right on taking up water without stopping. If it could it would get so full of water that we could not breathe it.

"So when the air which has taken up all the water it can hold rises into the sky it becomes chilled and condenses into clouds. The reason we can see them so plainly is because there is such a large mass of air chilled at one time. When a large mass of air is chilled near the earth it forms mist or fog.

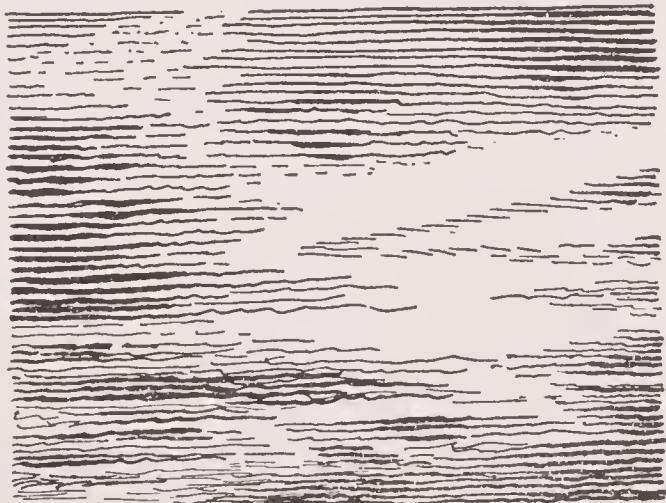
"A mist or fog does not seem to move, but the clouds do. This is because they are blown along by winds which we may not feel here below."

Then he began to show them the pictures in the book. "Here are four kinds of clouds," he said.

Ted looked at them closely. There were the straight clouds, the curly clouds, the white-of-egg clouds, and the rain clouds.

Then Daddy told them their names. The straight clouds, it seemed, were called stratus.

"Stratus," said Daddy, "means 'layer.' And we call them stratus because they come in 'layers' or bands. They are caused by the settling of other clouds. For this reason we often see them in the early morning or in the evening, when the warm air is not rising very fast. The stratus cloud is the lowest of all clouds. It may become a fog by falling to the earth."



Stratus

The curly clouds, Daddy said, were "cirrus." because "cirrus" means a "curl" or lock of hair.

"They are not low," he said, "like stratus clouds, but high. So high that they are probably made out of ice



Cirrus

crystals. They sometimes form a ring around the sun or the moon. We call this ring a halo. Cirrus clouds are sometimes called mare's tails or cat's tails."

The white-of-egg clouds, they found out, were "cumulus," because "cumulus" means a "heap" and these clouds were heaped up in the sky. They were not so low as the stratus, nor so high as the cirrus clouds. And they came usually during the hottest part of the day.

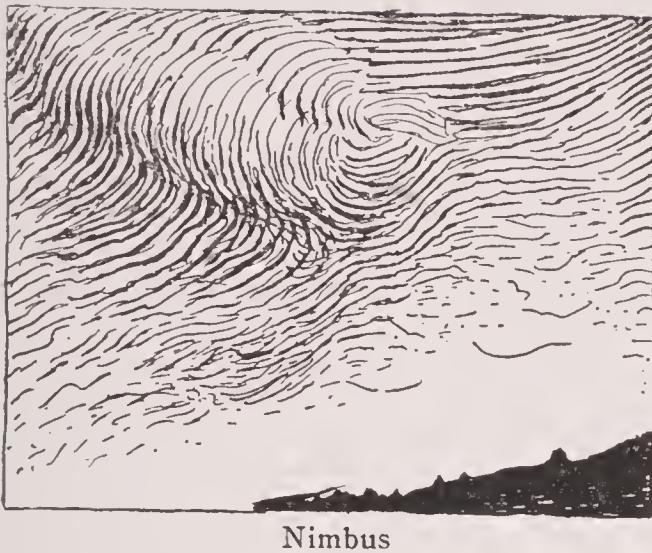
Then there was the "nimbus," or storm cloud, and that was the cloud from which rain fell.

They looked at the pictures a long time, the little girl as much interested now as Ted.

"Let's see," said Ted, "if we can say their names."



Cumulus



Nimbus

And so they tried, with Daddy to help them, until they could say them all. "Stratus, or layer cloud; cirrus, or curly cloud; cumulus, or heap cloud; and nimbus, or storm cloud."

"But, Daddy," Ted reminded him, "you haven't told us about the rainbow yet."

"Well," said Daddy, "you know we talked about Sir Isaac Newton the other day. I could tell you a good many things about him.

"One of the things he liked to do was to look through the three-cornered pieces of glass that hung from a lamp his mother had. When he looked through such a glass, he saw all kinds of pretty colors, red and blue and yellow. Such a piece of glass is called a prism.

"When he grew up he remembered about this and began to try to see what caused it. He bored a hole in a window shutter so that only a very small bit of light came through. He called this a ray of light. When the sun shone on the shutter, a sunbeam went through the hole into the room.

"The room was quite dark. He put a prism in the way of the light and on the white wall of the room he saw a pretty rainbow.

"This was not a real rainbow; it only looked a little like one. No one had ever seen this before; it was quite new; so it had to have a name; so Sir Isaac called it a spectrum. There was something else funny about this spectrum; it was not in a straight line with the ray of light that came through the shutter, but was bent to one side. This seemed very curious. Then he remembered that when he stuck a stick into a tub of water the stick looked as if it were bent. He went on thinking about this until he began to see how it was; the light was bent sure enough, and that was what was the matter. The stick was not bent at all; it only seemed to be bent; it was really just as straight as ever. But why did the spectrum show so many colors? There were red places and purple places and yellow and blue places; and they were shaded into one another, so as to look lovely. After he had thought about this quite a while he made up his mind there must be many kinds of light in a sunbeam. The sunbeam seemed to be white light but it was really made up of light of many colors, and when we get these colors together they seem white. Isn't that funny? Don't you think Sir Isaac must have been a pretty smart man?

"After this Sir Isaac began to remember about the rainbow, and he said to himself: 'I wonder if drops of water

behave like prisms?" So he tried it, and lo and behold, they do. Then he knew why we have rainbows and haloes. It is because the drops break up the light just as a prism does."

"Then a rainbow," said Ted, "is broken sunbeams."

"Precisely," said Daddy. "When the sun shines through the rain we see, not a white light, but a light broken up into red, orange, yellow, green, blue, indigo and violet. Can you say them?"

So they said them. "Red, orange, yellow, green, blue, indigo and violet."

"And that makes a rainbow," said Ted.

## CHAPTER X

Ted and the little girl next door were going on a picnic. Daddy and Mother and the little girl's family were going too, though you might not have known that from the plans the two made across the hedge. To be sure they would not have gotten far without the car, nor stayed long without lunch. And since the little girl's Daddy was going to drive the car, and the two mothers were putting up the lunch, it was necessary to take them along. But as for the fun they were going to have—well, if it takes older people to look after cars and lunches, it takes little people to provide the fun.

So they both wakened early and had breakfast before the sun was high, and then they started. They drove for miles and miles, first along the river, which looked like a smooth broad piece of silver; then past a village, where children ran barefoot, and where a big mill-wheel kept turning. It looked green and mossy, and the water kept dripping from it as it turned.

Then they drove through the woods, along a road that climbed higher and higher. The trees almost met overhead, and it smelted very sweet of birch and pine. At last they same to an opening in the trees. Here there was green grass, with ferns around the edge. And here they left the car and put down their baskets.

Ted and the little girl ran pell-mell through the woods, where the sunlight played hide and seek through the trees.

There was a rush of wings as the birds twittered and flew away. Only a chipmunk, bright-eyed and saucy, curled up his tail and watched them from a rock.

It was so still there you could fairly hear the stillness. It hummed like bees. It trickled like water. It rustled like leaves. It was sweet there too among the trees, and sweeter yet when they walked and trampled down the ferns.

"It smells like—like summertime," said Ted.

"It smell like ham sandwiches to me," said the little girl. And she ran back to her mother and the baskets.

When everything was ready Ted and Daddy went for the water. They had to go some distance through the woods. And when they got to the place they had to push the leaves away before they could dip down and get the water. It was very cold and very clear.

"Fine spring water," said Daddy, as he took a long drink of it.

Ted took a long drink of it too. And then they carried a big pailful back to the others. They filled the glasses. The little girl had hers in her silver mug.

"Oh-o-o," she cried. "There's a bug in mine."

There was. Ted poured the water hastily on the grass.

"There," he said, filling her cup again, "there are no bugs in it now. That one must have come off the leaves."

"What leaves?"

"The leaves that were on the water."

Her nose curled up in the air.

"I don't want water with leaves in it," she said. "And bugs!"

The little girl's Daddy laughed.

"Whoa, kitten," he said. "Worse things than leaves get into water. And you can drink worse bugs in the city than you are ever likely to on a hillside."

She looked at him with her nose still in the air. "I never drank a bug," she said.

"Not if you knew it. But the worst bugs are the kind you can't see."

"Why can't you see them?"

"Because they are too small. Now don't you think you need a sandwich?"

She nodded her head, and asked no more questions.

"Fine spring water," said Mother, just as Daddy has said.

"What is spring water?" asked Ted. He thought it must be some new kind.

"Why—why—just spring water, dear. Water that comes out of a spring."

Everybody was eating lunch by this time, so Ted said nothing more. Anyway the sandwiches were so good he forgot everything else.

But afterward while the little girl was taking a nap and the two mothers were knitting, he went with Daddy again to the spring.

"What makes spring water different from other water?" he asked.

"It isn't different, Ted. It is the same kind of water you saw in the village turning that big mill-wheel. And the same kind that flows in the river. Only up here on the side of the hill it is fresh and pure."

"Why?" asked Ted.

"Because when water falls from the sky in the form of rain, it is perfectly pure. After it falls either of two things may happen to it; it may either sink into the soil or run away over the surface into the nearest stream. If it sinks into the soil it passes on down until it strikes a bed of clay or a solid rock through which it cannot pass. Then it runs along the top of the clay bed or rock until it reaches an opening. Here it comes up to the surface in the form of a spring."

"Nearly all springs have nice cool water flowing from them all the time. A few springs dry up in the dry season, but many of them never run dry though much less water flows from them in very dry weather."

"I know a place where there are six or seven springs; several dry up in dry weather, but some of them go on running even in dry spells. One of them comes out at the bottom of a very high hill, almost a mountain. It is quite a large spring but never dries up. Another spring comes out along the side of a creek; still another comes to the surface half way up another hill. Upon the side of this same hill at different places and different heights other springs break out. If we dig holes in the ground and get them deep enough we always come to water."

These holes are almost always lined with stone walls and are called wells. Many people depend altogether upon wells for their water.

"Now whether the water runs along on the top of the ground in small streams, or runs under the ground and comes out in springs, it carries other things with it.

"It carries mud and sand, of course, and the farther it goes the more it carries. That is why water from a spring or well is purer than water from a river.

"But it also carries other things like salt, lime, iron and flint. That is why water from a well or spring is apt to be 'hard,' while rain water is 'soft,' as we say."

"Hard?" said Ted. "Water couldn't be hard."

"No, not hard like a stone. But we call it 'hard' because it has something like stone in it. If you take water from a well or spring and boil it in a tea-kettle, you are likely to find a hard crust on the inside of the kettle. That is because the water has flowed over limestone, perhaps, and has picked up some of the lime and carried it along.

"There are also iron-springs and sulphur-springs and salt-springs. People sometimes go to these springs and drink the water because they think the iron or sulphur or salt in the water will be good for them.

"The water from springs flows along until it forms a stream. Streams join each other and form rivers. The rivers flow on to the ocean. So all the lime and iron and

sulphur and salt which the streams have gathered up finds its way into the ocean at last. This makes the ocean so salty and bitter that we cannot drink it.

"Every drop of water that flows through the earth or over it carries something with it. The farther it goes the more it carries. That is why the purest water is rain water which has just come down from the sky. Or spring water, which is only starting on its way to the sea.

"We often catch rain water and hold it in cisterns, or spring water in wells. Sometimes, however, people take very poor care of these cisterns or wells and let dirty water, worms, toads, and mice get in. Then the water gets nasty and unfit to drink. Sometimes people who drink such water get very sick. Typhoid fever, dysentery, cholera, and a good many other diseases are caused by bad water. Those people who do not take good care to keep their wells and cisterns clean are very foolish, for there is no more easy way to get sick than by drinking bad water."

"I wouldn't drink bad water," said Ted proudly.

"Not if you knew it," said Daddy. "But you cannot always tell when water is bad. It may look clear and have no bad smell and yet be bad."

"Have bugs in it?" asked Ted. He was thinking about the little girl and her silver mug.

"Yes, just the kind of bugs you heard about to-day. They are so small no one can see them. But if they once

get inside of your body they increase and make you very sick."

"Ugh," said Ted, "I'll never drink any."

"I hope not," said Daddy. "But you easily might if it were not for the men who study to keep our drinking water pure."

"How do they keep it pure?"

"One way is by boiling it. If you boil water you kill the little bugs—or germs, as we call them. Another way is to use a filter."

"What is a filter?"

"A filter is sometimes a bed of sand. As the water flows through the sand the germs—or bugs—are caught and held while the water passes on. This is a kind of natural filter. But there are other kinds of filters too, which can be made, some of them small enough to use in the house. But they have to be kept clean, which is sometimes a trouble, so, on the whole, it is better to have water that is pure and clean to begin with."

"Like this," said Ted. And he stooped down to dip up another big drink of cool spring water.

## CHAPTER XI

It was very lonely in the yard. The little girl next door had gone away. She had gone on a trip with her father and mother to the Pacific Coast. But there was one good thing about it. Her mother wrote letters to Ted's mother. And there was so much in them about things that were new that Ted could scarcely wait to hear them read.

They had seen springs of water so hot that the water boiled. One place a man was fishing in a stream. And when he caught a fish he put it into the boiling spring and cooked it. Ted thought that this could not be true, but Daddy said that it was.

"But how did the water get hot?" asked Ted.

"Well," said Daddy, "do you remember how you learned that the earth was once a part of the sun? And how it turned so fast that it cooled off on the outside?"

"Yes," said Ted.

"Well, the earth has never cooled off all the way down to the center. It is still hot inside. It is so hot that it can melt rocks. And in some places there are mountains with a hole in the top. These mountains are called volcanoes. The hole is called the crater. And through this crater the melted rock is sometimes thrown high into the air."

"Gee," said Ted, "I'd like to see one."

"Perhaps you will some day, though there are not many volcanoes in America. The most famous volcano, perhaps, is Vesuvius in Italy, though there are many of them in South America and other parts of the world."

"And do they throw out rocks all the time?"

"No, not all the time. They may be quiet for hundreds of years and then suddenly begin to throw out steam and ashes and the melted rock, which we call lava. When they do that we say the volcano is active, or is in eruption. Can you remember that word?"

"E-ruption," said Ted.

"Now there are volcanoes along the Pacific coast in our own country but they are not active. We know by their shape that they are volcanoes, but they are not throwing out lava. They do something else, however, they heat the water that flows underground and so we have hot springs.

"There are hot springs in many places in the western part of our country. The Indians used to drink from them. They had many strange stories about them. They told a story about one spring that was very salty. They said that there was once an Indian chief who had beautiful daughter. Two young warriors each wanted to marry her, so they fought for her on the edge of a cliff. In fighting, both young men fell from the cliff and were killed. Then the young girl threw herself from the cliff and was killed too. Her father, the old chief, sat on the

hillside and wept so many tears over his daughter that they flowed down and formed the salty spring."

The next letter from the little girl's mother told about something more wonderful still. They were in Yellowstone Park and had seen not only hot water in a spring, but hot water shooting high into the air. This was called a geyser, and they had seen many geysers.

It was a wonderful place to be, she said, because here there were once active volcanoes. But all that was left now to show that they had been active was the presence of hot springs and of geysers.

The first place they went to was like a small hill or mound which was snow white. It was known as "White Mountain." It was so white that one felt as if it must be soft too like snow. But it was not. It was hard as a rock. It was built up like steps, some narrow and some wide. But the top was level. And on this level place there was a spring.

The water of the spring was hot and very clear. So clear that looking one way you could see in it a picture of the clouds overhead, as if it were a looking-glass. So clear that looking straight down you could see all the way to the bottom.

The water flowed over the edge, as it would over the rim of a wash-basin. And wherever it flowed it left the ground white. This was because there was lime in the water. And so while you felt as if you must be walking

on hardened snow, you were really walking over snow-white limestone.

And the water did not flow straight down on all sides from the main basin. Instead it kept forming new smaller basins. These were beautiful to look at. You might have supposed someone had carved them out of marble. And the edges reminded you of pearls.

Sometimes the color was rich cream at the bottom, and sometimes even bright yellow. There were even streaks of red to be found.

As the water flowed down the steps from basin to basin, it gradually cooled, so that one could have taken a bath in it, as warm or as cool as one wished.

In fact people did take baths in the water. Sick people came there to drink the water and to take baths in it. The water was drawn off in pipes for them to use.

And then Daddy told Ted that there were just such springs in other parts of the world where sick people went to bathe and to drink the water. Some of them were very famous and many people were cured of disease by going to them. And all because the water had in it some of the rock over which it had flowed.

The letter went on to tell about the next place they went. They travelled along Firehole River. The water of this river was warm. And streams of warm water flowed into it from all sides. It was a very strange place. All around were mud holes which kept bubbling up. The ground sounded hollow under their feet.

There were mud holes that puffed out sulphur and water; there were great openings that looked big enough to swallow a horse; there were boiling streams that flowed over a crust of yellow, green, and red.

There were lovely pools of blue water, but before you could get near them a puff of steam would dart out of the path under your feet. The air was full of strange noises, which made you feel as if you were in a factory of some dreadful kind.

The first geyser they saw was "Old Faithful." They called it that because the water shoots up regularly every hour. It stood on a mound something like the one known as "White Mountain." There were the same kind of little basins in it, filled with hot water.

The chimney of the geyser was taller than a man. Steam was coming from it all the time. And then every hour the water would begin to push up with a gurgling sound. Each time it would rise a little higher until at last with a great roar it would shoot away up into the air. After about five minutes the water would fall back again into the basin. It would then flow over the edge and down the sides.

Another geyser called the "Giantess" was still bigger. The water would boil out of this, sending great clouds of steam into the air. It would rise, not only in one main stream, but also in many smaller ones. These would cross each other, and where the sun shone on them would

sparkle and look like rainbows. Around the clouds of steam would be a bright ring of color, a halo, with all the colors of the rainbow. It was very beautiful.

Near to one of the geysers was a kind of cave, called the "Grotto." Some of the first people who saw it years ago thought it really was a cave and went in. It had beautiful stone pillars and arches, which they wanted to look at. Fortunately it was not until after they had come out that it began to gurgle too, and soon it threw steam and hot water up sixty feet into the air. Sixty feet would be ten times as high as a man, so they were glad they were out.

The most wonderful one of all was called the "Grand Geyser." Before an eruption the basin would fill with boiling water, and there would be a great rumbling in the earth. Then big clouds of steam would rise into the sky. After that the water would shoot up ninety feet. And from the top of this, smaller jets would rise as high as two hundred and fifty feet. There would be a hissing sound in the air. And the earth would tremble as the water from the great fountain would fall back. Many rainbows would sparkle around the top of it.

No trees or grass could grow around the geysers because the hot water with sulphur or lime or other things in it would kill them. If any living tree or animal did find its way there the water would turn it to stone. Pine cones had been fished out of hot springs, turned to stone

or petrified, as we say, also butterflies and grasshoppers, which had accidentally fallen in.

But the biggest news was that just before they left Yellowstone Park a new geyser, the biggest one of all, began to be active. No one was expecting such a thing, when suddenly a quiet mud pool sent steaming hot mud and rocks three hundred feet into the air. The road over which they had just driven was covered with water and they themselves were almost hit by rocks which were thrown up. They did not like to be quite so intimate with a geyser as this, and wished that the big fountain had sent out word when it was going to perform.

But still it was interesting to be right there to see it. And before they came away they heard that it was going to be named Semi-Centennial, because that word means fifty years, and it was fifty years since Yellowstone Park was opened.

## CHAPTER XII

One of the letters told about seeing the Colorado Canyon. Mother read it in a hurry. She was just dressing to go out. Ted hoped she would read it to him. But instead she began putting on her hat. It took Mother some time to put on her hat. He wondered why. He could put on his hat while he was running down the street after Daddy.

"What is a canyon?" asked Ted.

Mother pushed the roses a little lower over her ear.

"Oh, just a—a kind of gorge, dear."

"Oh," said Ted. He wondered what a gorge was. But by this time Mother had pulled the front door shut after her. So he had to think it out by himself. He rather thought that Colorado was the name of a state. And a canyon was a gorge. And a gorge was—well, perhaps it was an animal. Something like an Angora goat.

He asked Nora but Nora did not know. So there was nothing to do but wait until Daddy came home. It was lonely, too, waiting, with Mother away and no little girl to play with. He sat very still on the porch and kept wondering whether a Colorado Canyon had four legs or two.

At last he saw Daddy coming down the street. He ran to meet him. "Daddy," he cried, "what is a Colorado Canyon? Is it anything like an elephant?" For you see by this time he was sure it must an animal.

Daddy laughed all over his face as he took hold of Ted's hand. "Yes," he said, "it's a good deal like an elephant—in one way. It's the biggest thing of its kind."

"What kind?" asked Ted.

"Suppose we talk about it when we get to the house," said Daddy.

His face had sobered down now—all but his eyes. But Ted knew there was a joke somewhere. He knew too that Daddy would tell him after awhile. That was one thing about Daddy. He always shared his jokes. And while he often laughed *with* you, he never laughed *at* you.

"Did you ever watch the water making little gulleys in the garden when it rained?" he asked.

"What is a gulley?" asked Ted.

"A gulley is a path that the water makes for itself when it runs off the earth in streams."

"Then I have," said Ted. "I watched it a long while the day we saw hailstones. The rain ran down like—like anything. It made holes in some places. And it ran off just the way you say in—in gulleys."

"Then you have some idea," said Daddy, "of the strength or force of water. And just as a small stream will wash out a gully, so a large stream or river will make a path for itself called a gorge or canyon."

"Oh," cried Ted, "is *that* a canyon?"

"It is. And the Colorado Canyon is the path which the Colorado River has cut for itself through the rock."

"Through the rock! How could it cut through rock?"

"By the force of the water. Would you think water had so much force?"

"No," said Ted soberly. He was thinking how the raindrops chased each other down the window pane that day; how they ran into each other and formed streams; how the streams joined and formed larger streams; how they finally dropped to the ground and ran off down the garden. And yet to begin with they were just single raindrops.

"Well," said Daddy, taking up just what Ted was thinking of, "a raindrop isn't very big. But if you put enough raindrops together, they can do almost anything. And a river is just a great number of raindrops."

"There is more rain falling too in some places than in others, and that has something to do with the size of rivers. There are places in the middle west where there are rushing streams when the spring rains come. But in the summer there is no water in them at all because there is no rain."

"On the Pacific coast, however, the rainfall is nearly twice as much as it is in some other parts of our country. And this rainfall feeds such big streams as the Colorado River, which begins, or rises as we say, in the Rocky Mountains and flows south for twelve hundred miles

until it empties into the Gulf of California. It is while crossing the state of Arizona that it has worn the deep path or gorge known as the Grand Canyon."

"Gee," said Ted, "that must be some river."

"It is," said Daddy. "It is an elephant of a river." And again his eyes were laughing.

"But after all it is not very different from the trout stream where we camped in the spring, except that it is much, much bigger. For all rivers are formed in about the same way.

"Most of them rise in the mountains, flow swiftly down narrow gorges, cross the lower land through valleys, and then flow away quietly across the plains to the ocean. Some one has named these three stages, the mountain track, the valley track, and the plain track of a river. Of course not every river has just these three tracks, but most of them have.

"Now a river not only finds a path for itself. It also helps to make one as it goes. When it starts from some small spring it has little in it but pure water. And this water has little force. As it goes along, however, it uses what little force it has to gather up sand or gravel. And this sand or gravel helps to wear away the rocks over which the water flows. It is a good workman. It picks up its tools as it goes.

"By the use of these tools it keeps hammering away at its path making it both deeper and wider. Also as

it hammers at the rocks it breaks off pieces of them, and these pieces become in turn tools for further hammering. So that the farther the river goes, the more tools it picks up.

"These tools, however, do not keep the same shape all the way. As they rub against each other, they wear off each other's corners, so that in time they become almost round like marbles. That is why we can find pebbles in almost any stream of water.

"Some one has said that there are places on the River Rhine where you can hear the pebbles grinding if you listen closely at the bottom of an open boat.

"Now this grinding makes the path deeper, as we said, and since water flows faster the higher up it is, this grinding and deepening of its path goes on faster in the first stage of its journey, or the mountain track, as it is called.

"When it reaches the second stage or valley track, it seems to widen its path more than it deepens it. There are several reasons for this. One is that the river uses its tools not only on the bottom of its path, but on the sides as well. And so it keeps pushing its banks farther and farther out.

"But there is another better reason than this. The force of the water itself is greater by this time, because there is more of it, and it has a way of pushing first against one side, then against the other.

"This happens in all valleys, but especially in the wider ones. In this way the river keeps working on both of its banks. When it has pushed as far as it can in one direction, it has a way of turning and pushing in the other. That is why we see so many bends or turns in some rivers.

"Now all this grinding and pushing has been going on for years and years. And water can wear away anything, even hard rock, if it has time enough.

"But there is a difference in the kind of country around rivers. Sometimes the earth is soft or sandy, and there are many small streams flowing through it. Then it is easy for these streams to find their way to the river. And so we have a broad valley, sloping down to a river which has no high banks.

"On the other hand, if the country is very rocky, it is not easy for small streams to flow through it. Then the water is shut in between the rocks and forms a river. And the river, which cannot easily spread out, cuts deeper and deeper down into its path, or channel as we say.

"This is what has happened to the Colorado River in Arizona. It cannot easily spread out because of the rocks, so it has cut deeper and deeper until it has formed the most wonderful gorge we have in America, called the Grand Canyon."

Just then Mother came home, and when she heard them talking about the Grand Canyon, she went to get the letter about it, and read it to them.

"This is the most wonderful gorge in the world," the letter said. "You can look straight down half a mile to the bottom of it. It is fifteen miles wide in some places and so brightly colored that it looks like one big paint pot."

"Colored?" said Ted. "I thought it was just rocks."

"It is," said Daddy.

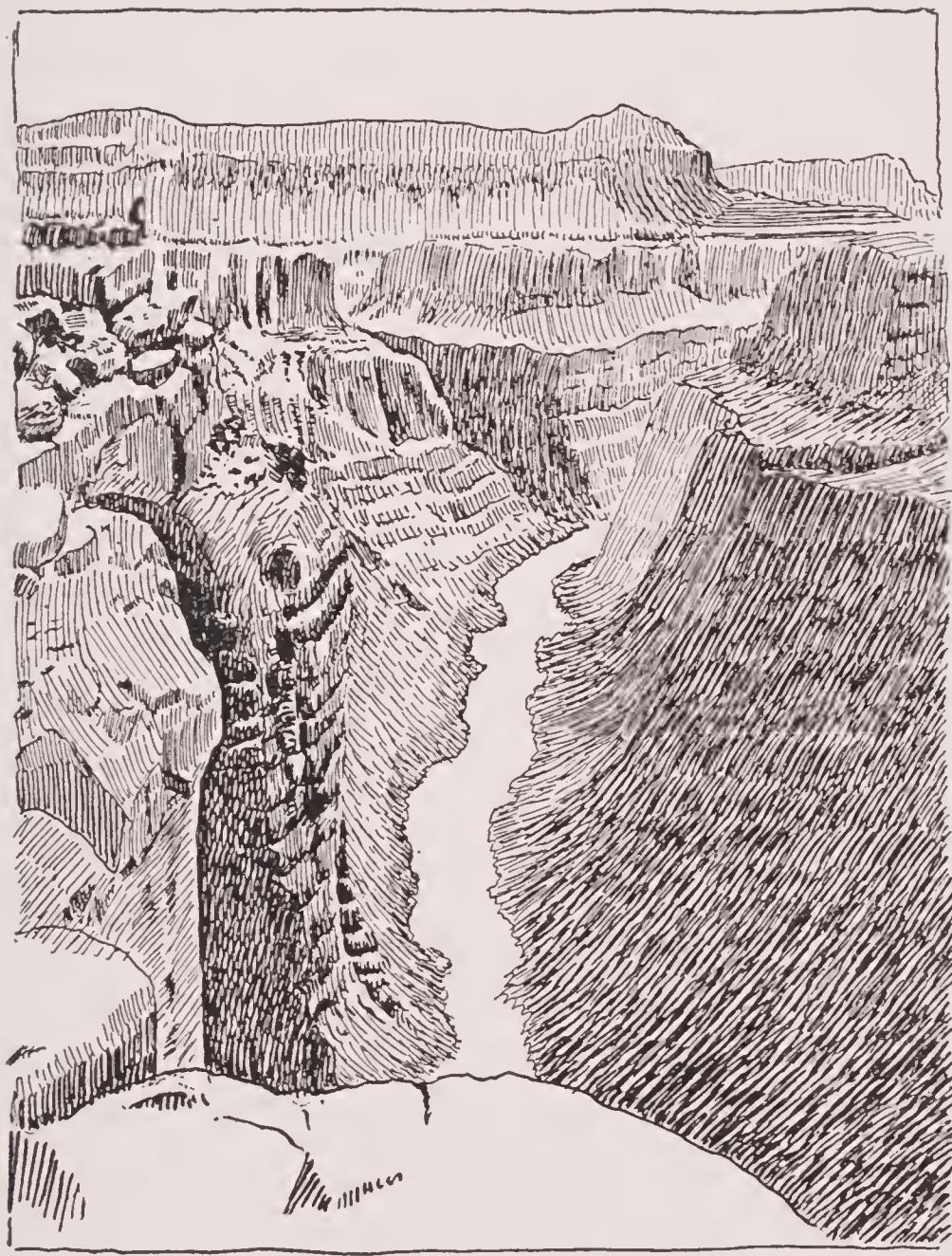
"I think there was a picture of it in the letter," said Mother, and she went back to her room to look for it.

"How could rocks be colored?" asked Ted. "Except just gray, of course."

"Rocks can be any color," said Daddy. "Some of the brightest colors in the world are found in rocks."

By that time Mother had found the picture. And sure enough there were the colors, blue and yellow and red, just like stripes in a ribbon. Ted kept looking at it while she went on with the letter.

"Think of all the brightest colors there are, painted on the steepest, highest rocks there are, and you will get some idea of the Grand Canyon. For the river year by year has cut down through one kind of rock after another, sandstones, white, yellow and red, and limestones gray and blue, until it has reached the hard red rock over which it now flows. With the sun shining on it



Grand Canyon

it is a picture never to be forgotten. We went down the Bright Angel Trail. You see it in the picture."

Ted handed the picture over to Mother, so that she could see the Trail. And as he did so, he found something written on the other side.

Why it was addressed to him! . And on it the little girl had written—or rather printed—"I WENT DOWN HERE ON A DONKEY."

## CHAPTER XIII

Ted sat thinking very hard one day not long after he had heard about the Grand Canyon.

"Daddy," he said, "I should think if a river kept on cutting down the rocks long enough it would get so far down we couldn't see it."

"Well," said Daddy, "probably it would if that were the only thing it did. But all kinds of things are going on all the time around us.

"One thing is that the land which slopes toward a river is constantly being washed down by rain and smaller streams. So if the river is getting lower down, its banks are getting lower down too.

"Another thing is that the river does not spend all its time cutting away the rock. Part of the sand and gravel which it carries it leaves on the bottom or along the sides. So it partly tears down its path and partly builds it up."

Ted thought this was queer.

"Do you remember how the water ran out into the alley one day when it rained hard? And it left such a pile of mud and sand that we couldn't open the gate?"

"Yes," said Ted. "And I helped you shovel it away. And there were twigs and grass and all kinds of things in it."

"Well," said Daddy, "there are all kinds of things in a river too. There are plants and dead branches and

leaves of trees. And the bones of animals that have died. And they keep floating along until they catch somewhere on a rock or a bend in the river. And there they stay. And after awhile other things come and catch there too, and so they get heaped up higher and higher.

"Fortunately not all the things which a river carries are left along the sides. If they were, they would take up so much room that the river could hardly find a place to flow. Some one has figured out that our largest river, the Mississippi, carries enough in one year to make a pile one mile square, and two hundred and sixty-eight feet high."

"Gee," said Ted, "how big would that be?"

"Well, it would be as high as a very tall building and as large around as ten city blocks on each side."

"Gee," said Ted again, "that would be some pile. What becomes of it all?"

"Some of it flows into the Gulf of Mexico."

"What is the Gulf of Mexico?"

"It is a piece of the ocean."

"And where does the rest go?"

"It spreads out over the land."

"All of it?"

"Well, no, not all of it. Some of it is always floating in the water."

Ted went on thinking.

"Gee," he said, "a river is a funny thing."

"A river is a mighty thing," said Daddy. It is like a big servant which nature uses to help her. It is always carrying rock and sand and mud from the mountains, which are high, down to the plains, which are low. In this way nature seems to be trying to make all the land as nearly even as possible."

"Maybe some day it will be even all over," said Ted.

"I hardly think so," said Daddy. "And this is one reason. The more sand and mud a river leaves on the plain, the less place it has to flow. And the less place it has to flow, the less strength it has to carry things with it. So a river gets tired and grows old after awhile, like a person."

"My," said Ted, "a river *is* like a person, isn't it?"

"Yes. And some people think so much of rivers that they study them all their lives. These people tell us just how a river carries its load.

"When it first starts on its journey from the mountains it tries to carry everything with it. But after awhile, like a traveler getting tired, it begins to drop first one thing and then another. And the things it drops first are the heaviest things, like rocks and pebbles.

"A river may stop on its way, too, when it finds a rocky basin. It may fill this basin and become what we call a lake. When it flows out of this basin it becomes a river again.

"But while it is there in the basin of the lake, it lays down a great deal of its load.

"There are two kinds of lakes, fresh water and salt lakes. When a river flows into a lake basin and then flows out again, the water stays the same and the lake is a fresh-water lake.

"However if the basin is very large and the river flowing into it is small, it may not flow out again. It may lie there until the water evaporates. You remember what that means?"

"Yes," said Ted. "It goes up into the air."

"Yes. And when it goes up into the air it leaves behind, not only the sand and pebbles it was carrying with it, but also the lime and salt and other things that had melted or dissolved in it. That makes the water that stays in the lake very salty. Such a lake is the Great Salt Lake in our own country. Another is the Dead Sea in Palestine, on the other side of the world.

"The water in these lakes is so full of salt that if we should try to swim in it, it would buoy our bodies up so that we could not sink. From such lake basins we get much of the salt that we use on the table.

"Sometimes, if the river is very small, it evaporates entirely after entering a lake basin, and the lake becomes dry. It is then called a sinking river. But the river does not really sink. Instead it rises into the sky.

"Usually though, when a river enters a lake, it flows out again on the other side. And the lake is a fresh-water lake.

"When the river has left its stones and pebbles behind, it still carries mud and rubbish. When it gets to the plain, it spreads these out in the shape of a fan.

"Sometimes the point or handle of the fan will be quite high because the coarsest things are dropped there first. It may even be high enough to get in the way of the river, and so make it change its course to one side or the other. Or the river may cut right through it and form another fan farther on.

"On the low ground all around, the river spreads out its carpet of mud, which is called a flood plain, a little higher every year. And then because it is higher, the river must find its way through it as best it can.

"So it wanders this way and that, making new paths for itself from time to time. This is sometimes dangerous, for when the spring rains come a river may overflow its banks and do much harm.

"The great river we just talked about, the Mississippi, does that very often. But at the same time that it does that, it does something else, too. In the first place it loses much of its force as it spreads out. And it also finds trees and shrubs that help to keep it from spreading too far.

"But besides all this, it loses so much of its mud that it builds up banks of it, and these banks help much to keep the river from going any farther."

"Sometimes when there is a small flood, the water goes over these banks and then settles back again. Then you can see the banks quite plainly between the main part of the river, and the part which has flowed over into the fields and meadows beyond."

"Sometimes too, a river builds up steps along its way. Each step is higher than the one before as you go farther up the river. You may see them on one side or on both sides of the river. They are what is left of old flood plains. As the river leaves each flood plain, it spreads out and widens its valley. So that much of the plain is covered. That is why you sometimes see the steps only on one side of the river."

"When you reach the end of a river, where it empties into the ocean or some part of the ocean, you may see a three-sided piece of land called a delta. This is where the river has left the last of its load."

"A—a—what?" asked Ted.

"A delta. The Greeks named it that, because it looked like one of the letters they used, to spell with, called delta."

"Oh," said Ted.

"This delta is made up of mud which is very good for things to grow in. In some places farmers depend on

it for getting good crops. The most famous deltas are those of the Mississippi in our own country and of the Nile over in Egypt.

"The farmers in Egypt have been growing crops for thousands of years. They could not have had these crops except for the River Nile. For Egypt is a hot country and has almost no rain.

"Each year, however, the Nile overflows its banks, and in the wet mud it spreads out, grain grows to feed the people. If it were not for this wet mud, the people would starve.

"It has been feeding the people all these thousands of years. So it is no wonder that long ago, before people knew as much as they know now, they thought the river was a god, and they worshiped it.

"That was funny," said Ted.

"Not any funnier than some things people do now. But even if we do know that a river is not a god, we must not forget that a river is a good friend. It gives us water to drink, to bathe in, to wash our clothes and our dishes in. And it also helps to give us the food we eat. So a river is one of the best friends we have."

## CHAPTER XIV

The next postcard which the little girl sent was from Kentucky. They were on their way to the Mammoth Cave. Ted hoped they would send a letter about the cave. He wondered what it looked like.

Daddy said that it had been carved by water in very much the same way that a river cuts out its path. But Ted could not quite understand this. It would take a good deal of water to do much carving. And how could a good deal of water get down into a cave?

He was thinking about it the day that they took a trolley ride over to some new works that Daddy wanted to see. One of the things they saw there was a kind of fountain, where the water shot up from a pipe into the air, as it did in the fountain in the park.

Ted wondered about this and Daddy told him it was an Artesian well. He said that over in France there was a place called Artois, and once upon a time the people living there found that by boring into the earth they could find water. This water they did not have to lift out in buckets as people do from some wells. It would rise itself, so that it could be carried for some distance in pipes. This was the first well of the kind known, and because it was found near Artois it was called Artesian.

There have been many such wells dug since then, Daddy said, and the water from them has been carried

in pipes, just as the water from this well they were looking at was going to be carried in pipes to supply these new works.

"But why does it rise?" asked Ted.

"Well," said Daddy, "this water came in the first place from somewhere up in the mountains. And water has a strange habit. When it gets a chance it always tries to rise again as high as the place it came from."

"It has been flowing underneath the rocks where it could not get out, until men dug a hole straight down to where it was and put in a pipe. Then it was so glad to get out it came straight up the pipe as far as it could go."

"Flowed *underneath* the rocks?" said Ted. "I thought water flowed *over* the rocks."

"It does both. There is only one place where you can dig an Artesian well. That is where the water is shut in *between* the rocks. Then when you dig through the upper rock the water rushes up through the pipe."

"That sounds," said Ted, "as if there were rivers under the ground."

"There are," said Daddy. "There are rivers and lakes and waterfalls underground."

"There are?" said Ted. "And you can't even see them!"

"Oh, yes, you can," said Daddy. "Sometimes."

"Where?"

"Well, the Mammoth Cave in Kentucky is one place."

"In Kentucky? Why, that's where—"

"Exactly. That's where your postcard came from."

"Tell me about it," cried Ted excitedly.

"The Mammoth Cave," said Daddy, "is the best-known cave or cavern that we have in America, but all caves are formed in much the same way."

"Of course there are some caves which have been formed by lava from volcanoes. The lava, you know, is boiling hot when it spurts up out of the crater. But gradually it cools, and as it cools it hardens on top. This leaves a space underneath. You may see the same thing in winter if you look at a brook after a warm rain. The water flows away under the ice which is partly melted, so that you can see something like a roof of ice with a space underneath."

"Of course this ice roof soon melts, but a lava roof does not. It may last for years and years and years. And then some day it may crumble away and show the cave underneath it, that has been there all the time."

"And there is another kind of cave found along the seashore. Such caves are made by the beating of the waves. When the coast is rocky, the water dashes very hard against the rocks in time of storm. Often the waves have pebbles in them. These pebbles, striking the rocks, soon cut an opening in them. When the opening is once made, the sea washes in and out, and in and out, until it has made quite a cave."

"Sometimes when the water rushes into these caves during a storm, the spray rises high into the air. Then the cave is called a spouting horn.

"But neither the lava caves nor the sea caves are very beautiful. The caves formed by underground water are."

"How does the water get underground?"

"Some of it soaks through the soil. The roots of plants and trees drink part of this. But the rest drips on down until it finds rock.

"If this rock is very hard, the water keeps on flowing over it. If it is soft like limestone, the water begins to wear it away. This wearing away makes caves or caverns.

"Now it happens that in Kentucky there is a great deal of limestone, so there are a great many caves. Some of them are so small that the water can hardly find its way through them in a rainy time. Others are very large. The Mammoth Cave is the largest of them.

"We can find out how these caves have been formed by looking carefully at the land. The country is high and level there. The rocks underneath have not been tilted about as they have been in some other places.

"There are only large streams there, and these flow in gorges with high rocks on each side. So whatever water flows into them from the sides must flow in under the ground instead of on top.

"There are no valleys in between the rivers as there are in most places. But we do find something else. We find sink holes.

"The water that runs off from the earth when it rains goes into these sink holes. There it runs down through an opening in the rocks that is like a pipe except that it is rough and jagged. When it is raining hard you can sometimes hear the water running down, as you could hear it run into a cistern.

"Sometimes the opening is so large that a man can be let down into it by a rope. In this way people have studied caves and the way they are made. For the opening at the bottom of the sink hole is the smallest part of this rough pipe. It gets wider and wider until it opens out into a cave. These caves may be any shape. They may be large or small. But if we study one we know how all of them are made.

"There are generally paths through the rock going out on the sides as we go down. And when we reach the bottom it is full of water.

"We find other things though besides water at the bottom of the cave. There are rocks and stones there, especially flint, that hard stone which the Indians used. We sometimes see flint sticking out of the walls. The Indians used to come to these caves to get the flint for their arrow-heads.

"These stones tell us a story. They are the tools which the water has used to carve out the cave in just the same way that a river uses tools to carve out its path.

"We call the main part of a cave the 'dome.' And opening out from it are more paths, or 'galleries,' as they are called. These galleries are where the water used to run out before the cave had been cut down as low as it is now.

"The bottom of a cave can never be lower than the nearby river. For the water in the cave flows into the river. But we know that a river keeps cutting its path lower and lower, and as it does so the water in the cave flows down lower too. So that new galleries are formed from time to time.

"As the water flows down through these new galleries, it leaves the upper ones dry, and we may find them along the cliffs at the edge of the river and walk in through them into the cave.

"This has been going on for so long that we may be seeing only the newer caves. There may have been others higher up that crumbled away before ever people lived about there.

"There are many strange things about a cave. One is that it never grows hotter or colder there. The air is of the same warmth summer and winter. For this reason if you go down near the lower opening or mouth of a cave on a summer day you find a strong wind

blowing. You may see the ferns and daisies waving before you even get to the place. This wind is so cold it makes you shiver. And the hotter the weather, the stronger the wind.

"And then if you go in the winter time to the sink hole over the top of the cave, you find the air pouring out there. But it is warm air. If the day is very cold this warm air may condense into a cloud of steam as it comes out.

"The reason for this is plain. In the summer time the air in the cave is colder than the air outside. And cold air is heavier than warm air. Therefore this cold air lies at the bottom of the cave and comes up out of the lower opening.

"But in the winter the air is warmer than the air outside. So this warm air which is lighter rises and comes out of the top of the cave.

"Caves have been used for many different things. People have lived in them, the Indians especially. We find Indian footprints all through the caves in Kentucky. The soft sand there will hold a footprint a long time. And we find tracks there of people who must have lived a hundred years ago.

"We also find there the torches that they used. They made them by filling hollow canes with grease.

"They must have hidden there in time of war. And there they buried their dead, with the little trinkets about

them which they thought people would use in the other world.

"White men used the caves too. They found saltpetre there, and saltpetre is used in making gunpowder.



Salt Petre Piper

When America was at war with England, much of the gunpowder they used was made with saltpetre from the Kentucky caves.

"They use caves too for keeping fruits and vegetables. The dry air and even warmth will keep such things much better than they could be kept on top of the ground.

"Animals also like to live in caves. Over in Europe there are caves which people have studied to find out

what kind of animals lived on the earth hundreds and hundreds of years ago.

"These animals either lived in caves, or were drowned and their bodies washed into caves, or were killed by other animals and their bodies dragged into caves.

"Their bones are still there. In the dry air of the cave these bones have kept their shape as they could not have done if they had been out on top of the earth. Men who study such things go there and piece these bones together. In this way they know what animals used to live on the earth as well as if they had seen pictures of them in a book."

"My," said Ted, "that's queer."

"Caves are books," said Daddy, "in which we read about what happened before there were any people on the earth."

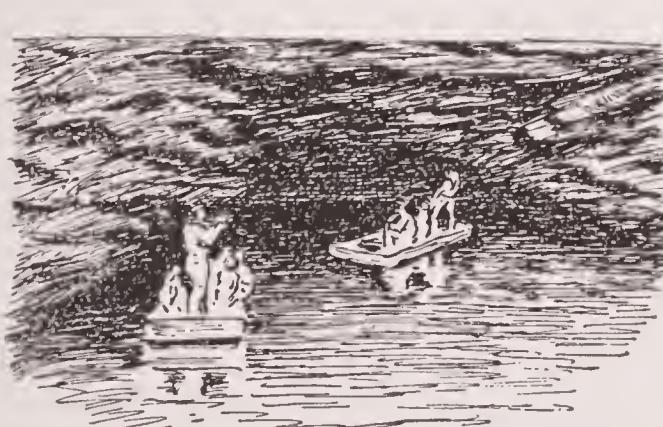
"Gee," said Ted, "wish I could see one."

## CHAPTER XV

When they got home there was a letter there from the little girl's mother. They had been through the Mammoth Cave.

"Oh, goody," said Ted. "Now we'll know what it's like."

It was very big, the letter said. So big that if one had time one could walk for days through places as wide and as high as a house. There were a hundred and fifty miles of walks through it. And it was only one of many such caves. There were eight thousand square miles of country just full of them.



Echo River

they came in from the outside, just as bears do in the winter time.

"Bears?" said Ted. "I don't want to go there."

Daddy laughed. "Well, I don't think the bears are there just now," he said. "You know bears sleep all winter, and they often go into just such caves to do their

There were lakes and rivers and waterfalls in it. One of the waterfalls was two hundred and fifty feet high.

There were animals in it too. Some of

sleeping. The animals probably knew all about this cave before people did. For one day a hunter was following an animal, and it ran in there. The man went in too, and found out what a big cave it was. That was how it was first known to white men, more than a hundred years ago."

There were bats there too in the winter time, so the letter said. If you went there then you could see them hanging from the ceiling in great bunches. Each one held on to the one above, and the top one held on to the ceiling.

They would hang there as still as if they were dead. And yet when spring came they knew it. The air did not grow warmer in the cave as it did outside, and yet somehow they knew it was spring. So they would wake up then and go out again into the sunshine.

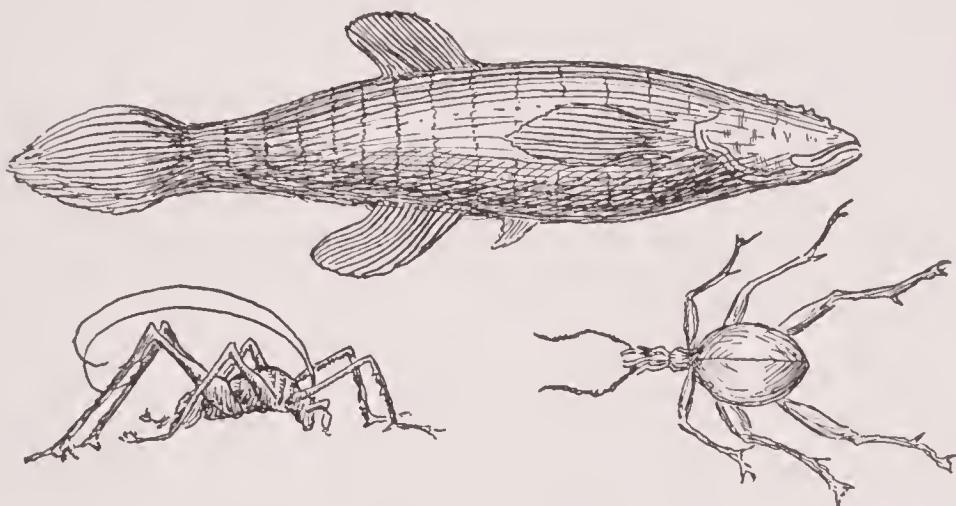
But besides the beasts and birds who went into the cave to stay for awhile and then go out again, there were other things that lived there. There were fish and bugs of many kinds. And they were blind.

"Blind?" said Ted. "How could they find their way in there?"

But from the letter he found out that they did not need to find their way in there. They had always lived there. And that was why they were blind. For they were not just blind like some animal that has had its eyes hurt. They had no eyes at all.

"No eyes!" said Ted.

Then Daddy told him why they had no eyes. It was because the cave was so dark, that they could not use



Blind Fish and Insects

eyes to see with if they did have them. And nature has a way of taking from us anything that we do not use. So these fish and bugs had lost their eyes.

Ted thought this was very queer.

But the most beautiful things they saw in the cave were the stalactites and the stalagmites.

"The—the—what?" said Ted. He thought he had never heard such big words before.

Daddy smiled. "Isn't there a picture of them in the letter?" he asked Mother.

There was. They were beautiful pillars which somebody had built along the galleries of the cave. Ted wondered who it was that had built them.

"Water built them," said Daddy.

"Water?" cried Ted.

"Yes. Water can build banks along the sides of a river. And water can build pillars up and down in a cave."

"How can it?"

"Well, it builds them in two ways. You remember we learned that water has different things dissolved in it. When it flows through limestone and forms a cave it has lime dissolved in it.

"Now as it trickles down through the ceiling of the cave drop by drop, it leaves a little of this lime sticking to the ceiling. Each drop that falls leaves a little more.

"This white lime looks very pretty there. It takes strange shapes. It often looks like a bunch of flowers hanging from the ceiling. But the longer the water keeps dripping, the farther down the lime hangs. It is called a stalactite.

"At the same time that the stalactite is forming, the water is dripping on the floor below. There it piles up a heap of lime too. And the longer it drips the higher the pile rises. This is called a stalagmite.

"At last the stalactite reaches down and the stalagmite reaches up until they join, and we have a solid white pillar.

"The water keeps on dripping down this pillar, making it larger and larger until finally the whole gallery is

filled with stalactites and stalagmites, and the water has to find some other way to get out."

"Gee," said Ted, "I'd like to see it. Did you ever see a stal - stal - "

"Stalactite?" said Daddy. "Yes, I saw some very beautiful ones in the Luray Cavern, in Virginia. This is just such a cavern as the Mammoth Cave, only not so large. But it is famous for its stalactites. You can see forty thousand of them from one spot.

"Some of them have been named. In one place you can see the Swords of the Titans, eight of them. They are fifty feet long, from three to eight feet wide, and from one to two feet thick. They are hollow, and if you strike them, they sound hollow.

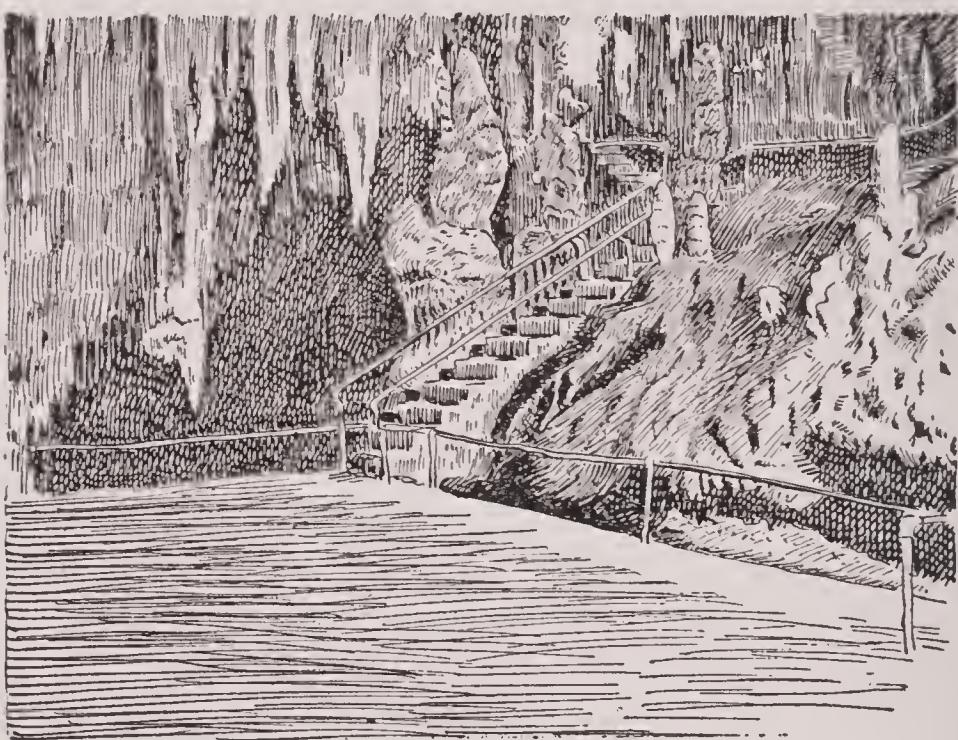
"As we went into the cavern, it was dark as night. Then our guide switched on the light, and we found ourselves in a kind of fairyland. Above us were the stalactites that looked like big icicles. Only instead of being the color of icicles, they were red or orange color or pink.

"On the floor around us were the stalagmites reaching up to meet the stalactites. They were of all shapes. Sometimes they looked like animals or people as the light fell on them.

"One of them was called the 'Indian's Blanket,' and when the light shone on it you could see beautiful stripes and a colored border.

"Another place was called Angels' Wings, where the stalactites spread out snow-white over our heads.

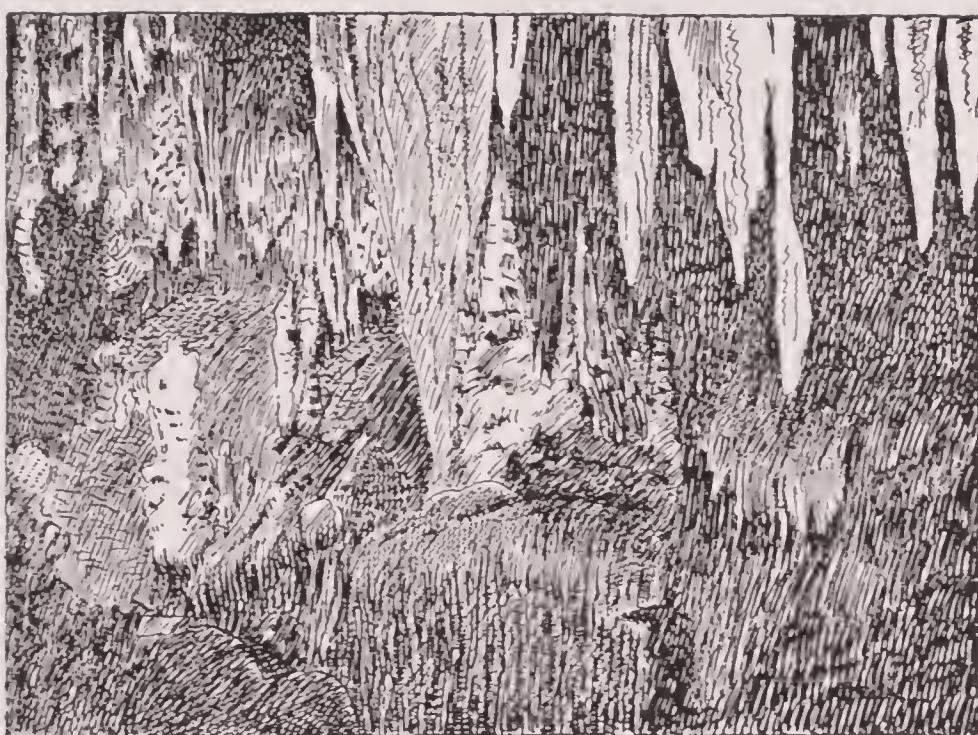
"The Ball Room looked as if it had been furnished with rich hangings and tall pillars. The guide said that twenty-three couples had been married in this place.



Ball Room

"In the Cathedral the stalagmites looked like the pipes of a great organ. And when the guide struck them with his fingers they sounded a little like an organ too.

"Some of the stalactites look like sea-weed, and are of different colors, from dark brown to pale pink. In one place there is a figure that looks like a marble statute.



The Organ

"One of the most beautiful lakes in the cavern is called the Silver Sea.

"Not far from the Luray Cavern is the Natural Bridge. This bridge is made of limestone, of many colors. It is two hundred and fifteen feet high, and one hundred feet wide. It is big enough to bridge over Broadway in New York City."

"Who built that?" asked Ted.

"Water built that too," said Daddy. "Long ago the water rushed through a cave or cavern there. But after awhile the walls of this cave crumbled away and only the ceiling was left. This ceiling is the Natural Bridge."



Natural Bridge, Virginia

Ted thought this was wonderful. "Water can do most anything, can't it, Daddy?" he said.

"Yes," said Daddy. "Water can tear down what man builds up, and build up what man would have a hard time tearing down. And yet water, which is so powerful, is a servant and friend to us all."

## CHAPTER XVI

Ted was very happy. He was going on a trip too. He was going with Daddy and Mother to Niagara Falls. He wondered if the Falls would be as wonderful to look at as the geysers and the canyons and the caves that the little girl next door had been seeing. Daddy thought that it would.

"What is a waterfall, Daddy?" he asked. "What does the water fall off of?"

"It falls off of rock. You remember that there are many kinds of rock, some hard, some soft. When the water washes down through soft rock to hard rock below, it forms a cave. But if a river flows over hard rock and then over soft, it gradually washes the soft rock away, leaving the hard rock above. This forms what we call a rapid. It is dangerous to row a boat through rapids, for the water is very swift and very strong there.

"But as time goes on the soft rock washes farther and farther down, while the hard rock stays much the same. So the water has farther and farther to go from the hard rock to the soft. This causes a waterfall.

"There is a line of rocks like this, along which the rivers flow, from New York down into Virginia. It is called the Fall Line. There are many waterfalls along the way.

"And just as a river uses the stones which it picks up to cut down its path, or to make a cave, so it uses them to cut away the soft rock below. So that after awhile there is a deep hole there, and the water has to make a big plunge to reach it.

"But while the water and stones are making this deep hole they are doing something else too. They are boring back in under the ledge of hard rock over which they flow. After awhile there is such a hollow there that the hard rock has nothing to hold it up, so it falls down.

"When it falls down it breaks, and the water uses the broken pieces as tools to cut away more of the soft rock underneath. So that a new waterfall is formed farther up the stream. In this way waterfalls keep moving from time to time."

"Does Niagara keep moving?"

"Yes. Since it first began cutting away the rock it has moved seven miles. There is a gorge seven miles long where it used to flow."

"How long ago was that?"

"Many, many years ago. More years than anybody knows except the people who study such things."

"How can they tell?"

"By reading the rocks. Rocks are like sheets of paper, laid one above another. Each one has a story written on it."

"What kind of story?"

"A story of what the earth looked like so long ago. And of birds and fish and animals that lived before there were any people."

"Gee," said Ted, "there's a lot to— to learn about, isn't there?"

It was a sunny morning when they reached the Falls. Ted could hardly wait to get there from the station. And when they did get there he thought he had never seen anything so wonderful in all his life.

The sun was shining on the water. It looked like a great stretch of green glass. Only it was moving glass. There was so much of it, Ted almost held his breath when he looked at it. And it made so much noise he could not talk.

After awhile they went down some long stairs and came to the bottom of the Falls. Here the water dashed so hard that they had to stand back to keep out of the spray. It seemed even bigger too looking up at it than it had from the top. Ted didn't know water could fall so far.

And yet Daddy told him that the Shoshone Falls in Idaho were higher, though not so large. And in South America and in Africa there were waterfalls still larger.

They took a little boat called Maid of the Mist and went through the Whirlpool Rapids. They drove about Goat Island. They crossed the bridge into Canada. They took a trolley ride through the gorge.

And then they came back to look and look and look at the Falls. One part was called Horseshoe Falls because it was the shape of a horseshoe. One part of the Falls belonged to Canada and one part to the United



Niagara Falls by Moonlight

States. In the winter time, Daddy said, the spray would freeze and cover the rocks. Then it was even more beautiful than in summer.

But there was one thing Ted kept thinking about. That was the force of it. It was beautiful, of course, but it was so powerful, too.

"My, but it must dash *hard*," he said.

"It does," said Daddy. "Hard enough to run factories and drive trolley cars."

"If they could only hitch it up to the factories and trolley cars," said Ted.

"They do hitch it up to factories and trolley cars," said Daddy.

"Really?" Ted looked doubtful.

"Really. Water power has been used for a long time in the world. Men learned long ago how to build a dam across a stream of water when they wanted to use it for power. They still do that to-day."

"They are talking right now about damming up the river Nile, the famous river we have talked about before. The Blue Nile, as it is called, has many waterfalls and rapids. After awhile it flows into a large lake. When it flows out of this lake it goes on to join the main part of the river, called the White Nile."

"This river, as you remember, overflows its banks and makes the soil very rich, so that it will grow good crops. And the British Government, which has control over some of the land in Egypt, thinks that more land still could be made rich enough for crops."

"If they build a dam where the water of the Blue Nile flows out of the lake, the water will flow over the land instead. And there will be just that much more land on which to plant grain."

"But generally they build dams to get power to run factories or mills, not to make soil to raise crops."

"Do you remember the day we drove up on the hillside for our picnic? And the old mill we passed with a big water wheel?"

"Yes," said Ted eagerly. "Where the children all ran barefoot."

"Yes," said Daddy. "Well that old mill was run by water power. They had dammed up the stream and when it fell over the dam it kept turning the wheel around.

"Now just such mill-wheels have been used for many years. And one day people began to think about Niagara. Why not use Niagara Falls to turn big mill-wheels, just as a small stream is used to turn smaller mill-wheels. So they set to work to think it out.

"They found that five million tons of water go over the Falls every hour. And that that water has as much strength as three million horses to pull a load."

"How much is a million?" asked Ted.

Daddy smiled.

Then Ted remembered what Uncle Bob had once said about a million miles. It was more miles than you could walk if you went all the way around the earth. And three million horses—well that would be more horses than you could ever count, no matter how hard you tried.

"You couldn't even *think* three million horses, could you Daddy?"

"No," said Daddy, "I don't believe you could. And yet Niagara can pull as big a load as three million horses."

"How do they make it pull loads?"

"They build machinery."

"I didn't see any."

"No, strange to say, there is no machinery at the Falls. But about a mile farther up the stream there are buildings that have machinery in them. Perhaps we can go inside."

As it happened, Daddy had a friend who could take them inside one of the buildings. It was called a powerhouse. There were great round things in it. They were called dynamos. And each one made power enough to do as much work as five thousand horses.

There was no water turning wheels in the powerhouse. And yet the force of the water, by means of the dynamos, was making what we call electricity. And that electricity was running factories in the nearby city of Buffalo, and driving trolley cars along the gorge in Canada.

Ted could not get done looking at those dynamos. They looked like big tops. And they never stopped spinning. They turned two hundred and fifty times a minute.

The reason they never stopped spinning was that the water in the river was turning them. And the water never stopped flowing. Each dynamo turned on a rod. This rod ran away down into the ground. There it was fastened to a water wheel. This water wheel was turned by water from the river, which ran through a steel tube.

They were allowed to go downstairs and see this water wheel. All the way down they kept seeing the rods on

which the dynamos turned. Daddy said the building burrowed underground like a mole. Fifty feet of it were above the ground, and the other one hundred and fifty feet were below.

When they reached the lowest floor, they found that each rod ran into something big that was shaped like a turnip. From the sides of this turnip ran a steel tube. Through this tube the water came that turned the wheel inside the turnip. By the turning of this wheel the dynamos upstairs were kept spinning.

Ted felt almost afraid. Suppose one of the steel tubes should burst. Then the whole Niagara River would pour in and drown them. He took tight hold of Daddy's hand.

He did not know which was more wonderful, the green water dashing over the rocks up above and sparkling in the sunshine; or the invisible, silent water in the steel tubes, running factories and driving trolley cars and lighting streets at night.

Yes, water was beautiful. And water was powerful. For it was water alone that was doing this work. It was not steam. There was no coal used to boil the water to make steam, as they use coal in steam engines. It was just water itself.

Ted looked at the dynamos again when they went upstairs. There were eleven of them. And in the building on the other side of the river, he was told, there were ten

more. There would soon be five such buildings or power-houses, ready to send out power to other cities.

He wondered what became of the water after it had flowed over the wheels and set the dynamos spinning. Daddy's friend told him that it flowed away far underground and came out at last into the Niagara River below the Falls.

One thing seemed very strange. The electricity made by the dynamos could be used not only right there near the Falls. It could also be carried to other cities. It was a long time before men found out how to do this. At last they found a way to carry electricity along wires to other places. Daddy told Ted that some day when he was older he would be able to understand how this was done.

But the electricity was used now in Buffalo and in Toronto. And some day it would be used as far away as New York and Chicago.

Ted could hardly believe this. It had taken them all day to travel from New York to Niagara Falls. And yet sometime they might sit and read a book in New York by light which came from Niagara Falls. Surely water was a wonderful thing. There seemed to be almost nothing it could not do.

## CHAPTER XVII

It was very cold one morning in December. So cold that Ted could not see out of his bedroom window. The window had been raised during the night. But when Mother came in and put it down, it was all covered with frost-work. Ted wondered how it ever got there.

"Daddy," he called. "Come see my window. It's just like—like lace."

It was like lace. Daddy thought so too.

"What makes it?" asked Ted.

"What makes dew?" asked Daddy.

"Why—why—con-den-sation," said Ted.

"Well, that makes frost too. You remember last summer how the dew would lie thick on the garden in the morning?"

"Yes."

"Well, in the fall, it was frost, not dew, that you saw there."

"Oh, I know," said Ted. Uncle Bob said he'd tell me all about it when the time came."

"Then we'll make him do it," said Daddy.

"But why does it make patterns?" said Ted. "Dew is just round drops."

"Nature does many wonderful things," said Daddy. "She has many different patterns. She can take a drop of water and make it round like a dewdrop, or raindrop. That is one pattern. Or she can make it look like a pearl

in the garden in October. That is another pattern. Or she can make it look like lace in the winter time. That is still another pattern. It all depends on how cold it is.

"The frost we see on the garden in October is called hoar frost. It is different from the frost which forms in winter, when the ground is frozen farther down. Uncle Bob has some pictures of frost taken under a microscope. We'll ask him to show them to us."

"Some of the frost crystals look like the stalactites in the Mammoth Cave you heard about."

"What is a crystal?"

"A crystal is a pattern. There are frost crystals and snow crystals and ice crystals. They are all different. Uncle Bob can show us pictures of them all."

"I didn't know ice came in patterns."

"It does. And so does snow."

"How big are the crystals?"

"So small you can only see them through a microscope. Crystals of hoar frost often look like needles. Sometimes they look like a flock of butterflies, or like a tree with branches."

"Frost crystals are not like dewdrops in one way. Dewdrops form on the tips of leaves or blades of grass. Frost crystals form nearer to the ground."

"Frost crystals on a window-pane often look like an evergreen forest, like a bunch of ferns, like oak leaves, or like a handful of feathers."

After breakfast Daddy took time to show Ted just how the crystals form. They went to the back porch, which was closed in with windows in winter time. Of course there was no heat there, and the window-panes were covered with frost.



A Design of Frost Crystal from the Land of Pointed Firs

They took a candle and placed it near enough to the window-pane to melt the frost. As the frost melted, the center of the pane became clear, but there was a thin

film of water around the edge. Then they took the candle away.

At once the frost pictures began to grow. All around the edge fern leaves began to form and reach out toward the center. As soon as they got to a dry place they stopped. Then in between the ferns other, smaller, things began to form, like feathers. After awhile they stopped too.

Then on the dry places the true frost began to show. For the ferns and feathers were formed out of the



A Maple Leaf Frost Etching

water film already on the edges of the window-pane. But the true frost was formed out of the water in the air itself. It took the form of thin lines and stars.

Soon it covered all the clear space. But it never touched the ferns and feathers. Indeed it seemed to draw away from them.

When the window-pane was covered, it looked like a painting. The ferns and feathers were the picture itself. And the lines and stars were the background.

There are ten different kinds of window-pane frost, so Daddy said. But we never see all kinds at any one time. Besides that, no two panes of glass are covered with just the same patterns.

Daddy said that was because no two panes of glass were just alike. One might be thicker than another. Or one might have dust or scratches on it. And the frost crystals would follow the dust or the scratches.

Ted suddenly remembered how he and the little girl next door had once scratched the first letters of their names on the farthest window-pane. He did not tell Daddy, but afterward when Daddy had gone he went to look. Sure enough there they were. T and M all trimmed up in the whitest feathers you ever saw.

When Uncle Bob and Daddy both came home that night, it was snowing the most beautiful snow you ever looked at. Flakes of it lay on Uncle Bob's coat and on Daddy's when they came in. And outside it was like one big warm blanket all over everything. You could not feel somehow that it was cold and wet. It looked so beautiful and so very, very white.

Yet it was cold and wet. You found that out if you touched it. For it melted under your touch. But just before it melted it looked like tiny little feathers. Uncle Bob said it did not look so much like feathers under a microscope. It looked more like stars.

After dinner he got out his snow pictures, and Daddy brought the little girl next door over, so that she could see them too.

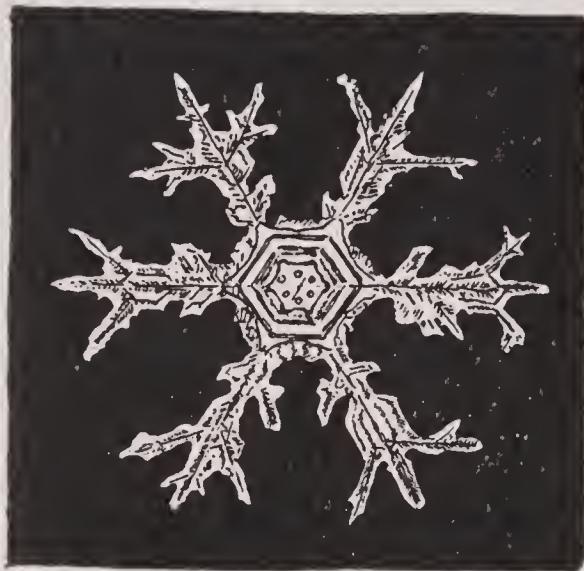
There were a great many of them, and no two alike. Uncle Bob said that one man had worked for years studying snow crystals and getting pictures of them for the Government. And he had found thirteen hundred different patterns.



A Very Symmetrical Snow Crystal

They were mostly six-sided and pointed. It was hard to get a picture of a perfect snow crystal, because they were formed so far up in the sky and had to travel so far to get to the ground that many of them were broken.

The snow crystals besides having beautiful shapes, had fine markings on them. This was because the crystal was hollow, and whenever there was a hollow space in-



Jeweled Type Snow Crystal

was caught by the wind and tossed about, back and forth and back and forth, but the more it was tossed, the bigger and heavier it grew. It kept adding points and lines. So the harder it had to fight to reach the earth, the more beautiful it was.

Because snow crystals have many sides and points, they catch the light in many places. And because they catch the light in many places, they are very bright and very white. That is why it dazzles one's eyes to look at the snow when it covers the earth. It catches so much of the light that it hurts one's eyes to look at it.

side it was filled with air. This air space looked dark against the white crystal, and so seemed like a mark or line.

When a snow crystal first began away up in the sky, it was quite small and simple. But as it started down, it



Blizzard Type Snow Crystal

And snow was not only beautiful, Uncle Bob said, it was useful too. For one thing, it would lie a long time on the earth and melt little by little. This would give the ground just the water it needed from time to time. In this way it was different from rain. For when it rained so much water would fall at once that much of it ran off instead of sinking in.

Then too snow was like a blanket to keep the earth warm.

"That's just what I thought," said Ted. "It looks like a blanket, a big white blanket."

"It is," said Uncle Bob. "There are many seeds in the earth. The snow keeps them warm and gives them the water they need. And then when springtime comes, they are all ready to sprout and grow up."

## CHAPTER XVIII

There were other pictures Uncle Bob had to show, pictures of ice crystals. They looked like flowers. These pictures were harder to get, he said, than pictures of frost or snow crystals. But it could be done.



Ice Flower Crystal Beginning  
to Show Shading

Men who studied such things went about it this way. They took a looking-glass and placed it in the water of a brook, or in a pail of water in a cold room in the house. It must lie just under the top of the water. In this looking-glass they could watch the ice crystals forming, but they had to use a microscope to see

them, for they were far, far too small to see any other way.

When the ice crystals began to form, they showed first on top of the water and around the sides of the pail. Sometimes they sent out needles of ice from the sides toward the center.

But besides these needles, there were other ice crystals that floated by themselves on top of the water. They were the most interesting and the prettiest. They began

by being just round. Then they started to form into a pattern. And when they were done they looked like flowers.

There were five kinds of ice crystals, the needle kind, the star with six points, the round kind, the branching kind, and the kind that looked like little pillars.

You could often see more than one kind in the same pail of water. And often the different crystals ran into each other and broke off each other's points, so that few of them were perfect.

The ice crystals formed not only from the edge out, and on top of the water, but from the top down. This was a good thing, Uncle Bob said. Because if they had formed from the bottom of a stream up, the fish would freeze and die. And the sunshine could not get far enough down to melt the ice when spring came.

But as it was, there was ice on top of a stream so we could skate. And yet underneath, the water was kept



Coral-like Branch Showing the  
Feather Type of Ice Crystal

warm enough by the ice which covered it, to give the fish a chance to live through the winter.

"What about icicles, Uncle Bob?" said Ted. "How do they form?"

"Icicles are formed from melting snow. When the snow on the roof melts, the water drips down and takes much the same form as stalactites do in a cave. When you look at an icicle you know what a stalactite looks like. And when you look at a stalactite you know what an icicle would be like if it lasted the year round."

Ted thought this was all very interesting. He was still thinking about it when he got up the next morning. He ran out to the back porch to see what new patterns there were on the window-panes there.

But he forgot all about the frost patterns when he got there. He was so surprised. Nora had set a milk bottle there the night before, filled with water. She had meant to wash it, but forgot to do so.

When Ted got there the bottle was split right through and the water was frozen solid. The queer thing was that this solid piece of ice had not stayed in the bottle. It was sticking out of the top.

"Daddy," he called, "Daddy. Just look at this ice. What makes it stick up like that? And the bottle is cracked clear through."

Daddy came to look and seemed as much interested as Ted.

"Do you remember?" he said, "the day you had to put your blocks away before Mother would let you go driving?"

Ted grinned. He never would forget that day. He was building a bridge when Mother called him. And he was in such a hurry to go that he piled the blocks pell-mell into the box. And of course the lid would not go on.

So he pushed them around and shook them, and still the lid would not go on. Then he took some out and straightened them. And still the lid would not go on.

And Mother just sat there and waited. And he had to take every block out, and put every block in again, just exactly where it belonged, before he could get ready and go driving with her.

Mother never forgot that. And neither did he. She reminded him of it sometimes even now, when he got in too much of a hurry.

So he laughed when Daddy spoke of it. And Daddy laughed too.

"Well," said Daddy, "When Nora put water in the bottle last night, it was just water. And it just filled the bottle. But during the night the cold weather changed the water into ice crystals. And ice crystals, as you know, have sharp points and corners."

"These points and corners ran into each other so that there wasn't room for them in the bottle, just as there

wasn't room for your blocks in the box when the corners were turned every way.

"Finally they pushed each other so hard that they split the bottle. And even then they could not find room enough but had to stick away out from the mouth of the bottle."

"Gee," said Ted, "I didn't know ice could do that."

"Ice can do more than that. Ice can crack big rocks. Even frost can crack rocks—split them apart as if they had been blasted."

"Frost?" said Ted.

"Yes. Because frost forms crystals too, you remember."

Ted could only shake his head.

"Ice can do as much as water, can't it, Daddy?" he said.  
"And ice *is* water, isn't it?"

He shook his head again. It seemed so strange. He could not quite take it in, all at once.

## CHAPTER XIX

It was summer again. Ted and Daddy and Mother were all very busy. Mother was packing and Ted was helping. And Daddy had a dozen things to do. For they were all going to Europe.

Ted could hardly wait for the day to come when they were to start. And when it did come, the train seemed to crawl that took them to New York.

But at last they were on board the steamship and ready to start. Ted wanted to look at everything at once. But the thing he wanted to see most was the engine that made the boat go. And this he had a chance to do.

The engine itself, or set of engines, was a powerful thing. But what seemed more wonderful still was the fact that steam could make them go.

He remembered the pictures Uncle Bob had shown him once of steam engines. It was just after he had burned his fingers in the steam from Nora's tea-kettle. It had seemed strange then that a little white puff of a cloud could run an engine. It seemed strange now.

And then Daddy told him how people had always been interested in steam. And how they had wondered for a great many years what it could do. He called the steam-engine a great invention, because an invention, he said, was something that people found out how to make for the first time. And he said that all great inventions were the work, not of one mind, but of many.

The ancient Greeks, it seemed, knew how to use heat to make things go, as much as twenty-one hundred years ago. There was a great city in Egypt at that time, named Alexandria. It was named after the Greek conqueror, Alexander. Many learned men lived there. One of them, named Hero, wrote a book. In this book he told people about an altar.

"This was interesting to the Greeks," said Daddy, "because they worshiped many gods and built many altars in their honor."

"This altar which Hero wrote about was hollow and air tight. Water could be poured into the bottom of it and a pipe led from this up to the top through a figure standing beside the altar holding a bowl.

"When a fire was made on the altar, it heated the air inside. This heated air in trying to get out would push the water up the pipe until it poured out into the bowl which the figure was holding.

"This made it look as if the figure was making an offering to the god for whom the altar had been built. And it pleased the Greeks greatly, for they liked to show much honor to their gods.

"Altars like this may have been built hundreds of years before Hero wrote about them. But this is the first time we hear about one. And the altar he tells us about is the first thing we know of that was built for the purpose of using heat to make things go. It was really a heat-

engine. And because heat is used to make steam, we might call it the great-grandmother of the steam-engine.

"Hero also tells us about a temple with such an altar in it. A temple was a house or church built in honor of a god. When a fire was built on this altar it too heated the air inside, and so forced the water to rise. As it rose it flowed into a bucket. The weight of it caused the bucket to drop down. And because the bucket was fastened to the posts of the doors, it would cause the doors to open as it went down. Thus heat was used to open the doors of the temple.

"From that time on heat was used in many ways. But it was not until much later that it was used to make steam. Indeed it was about eighteen hundred years after the time of Hero that a man in Italy made a machine something like the altar Hero wrote about. Only this machine used steam instead of heated air to drive the water out of the tube.

"Some years after that, in England, the Marquis of Worcester made something which he called 'A Fire Water-work.' This was probably the first real steam-engine.

"One man after another studied such small engines and made changes in them. One of the best-known of these men was James Watt.

"James Watt was born in a small Scotch fishing village on the river Clyde. This river is known now as the

place where many of the greatest steamships in the world are built. But at that time people had never heard of a steamship.

"James Watt had a happy home. His grandfather was a schoolmaster, and quick at figures. People called him a great mathematician. His father, who was a carpenter, was elected to the highest office in the town. Perhaps in America we would call him a mayor.

"But James, as a little boy, was not very strong. Often he was sick and could not go to school. At such times he liked to play with the tools from his father's carpenter bench. He seemed to like tools as his father did. And he seemed to like figures as his grandfather did.

"When he was only six years old, it is said, he could work out problems in geometry. And geometry is something people study when they get to High School or college."

"I know," said Ted. "Uncle Bob has a book in his room about ge-ge-ometry. It's all full of lines, and things."

"Well James Watt liked to draw just such lines. Only after he had made pictures with these lines, he would take a knife and a piece of wood and carve out something that looked like the picture.

"He made many interesting things, and for many years he made his living by making musical instruments and

instruments used on sailing ships. During this time he went to Glasgow and made friends with some of the students in the University there.

"One of them talked to him one day about the steam-engine. At once he began to study it. He kept on studying it for the rest of his life. He made many improvements on it. So many, in fact, that people almost thought he ought to be called the inventor of the steam-engine.

"Other learned men joined him in his studies. They used to meet every month at each other's houses. They met at full moon, so that those who had to come a long distance could drive home by moonlight. For they had no electric light in those days to make driving at night easy.

"He lived to be eighty-three years old and when he died he was buried in Westminster Abbey. This was a great honor. For only kings or very great men are buried there. And James Watt was thought to be great because he had made steam the servant and friend of mankind."

"Are we going to Westminster Abbey?" asked Ted.

"Yes. And when we do we'll read what is written there about James Watt and what he did for the world."

"And then did they build steamboats right away?"

"No, not right away. It was a good while before they found a way to do that."

"First of all they used steam in drawing up water, or in forcing water out of mines. Then they used it in factories to take the place of men or animals.

"But all the time they were wishing they could make steam take the place of horses in hauling people or things from one place to another. Or that they could use it on boats, instead of depending on the wind, as sailboats have to do.

"Many people studied about it. Several different men built engines that would go. One of the earliest was built by a man named Evans, and used in Philadelphia in 1804.

"But the man who did the most to make our present day railroads possible was George Stephenson. He built his first engine in England in 1814. He is sometimes called 'the father of the railroad.'

"People did not believe at first that engines could be built that would go very fast. Someone said to Stephenson, 'Suppose, now, one of your engines to be going at the rate of nine or ten miles an hour, and that a cow were to stray upon the line and get in the way of the engine. Would not that be very awkward?'

"'Yes,' he answered, 'very awkward—for the cow.'"

"But Daddy, that was in England. When did we have our first railroad in America?"

"Well," said Daddy, looking through a book he had in his hand all this time, "the first rails were said to

have been laid at Quincy, Massachusetts, in 1826. And the next between the coal mines at Mauch Chunk and the Lehigh River in 1827."

"And how many railroads are there now?"

Daddy laughed. "I wouldn't try to count them if I were you," he said. "The country is covered with them."

## CHAPTER XX

“But Daddy,” said Ted the next day, “you haven’t told me yet about steamboats. When did people begin to use them?”

“About the same time that they first used steam-engines to carry people over the ground. In fact steamboats had been thought about before steam-engines, because people had always traveled across the water in boats, as far back as we know anything about what people did. And it was natural to try to use steam to make these boats go, instead of wind.

“Many, many years ago people traveled in boats which they rowed with oars. But very soon they found that they could make a paddle-wheel which would turn in the water and do the same work as oars.

“As much as three thousand years ago there was a man named Homer. He wrote a book called the *Odyssey*. And in that book he talked about ships that were self-moved. It almost seemed as if he were looking forward to the day when ships would not need oars nor paddle-wheels. They would move by means of a power within themselves. And that power would be steam.

“As far as we know, the first time anyone really tried to make a boat go by means of steam was in 1543, in the harbor of Barcelona, in Spain. But the story about it says that people were afraid to ride in a boat where

boiling water was used, for fear it would blow up. So it was not tried again for a long time.

"In 1690 a man named Papin thought of using steam to turn the paddle-wheels of boats. But it was not until 1707 that he made an engine which would really do the work. Then he wrote a letter to the ruler of the country where he lived, called the Elector. In this letter he asked permission for his boat to pass down the river through the country owned by the Elector.

"He very soon got an answer saying that the Elector would not allow it.

"This was the end of his trying to make a steamboat. For the other boatmen thought that their business would be gone if ever boats were made to go by steam. So they came at night and tore his boat to pieces. He himself would have been killed, if he had not gotten away and gone to England.

"In 1736, in England, Jonathan Hulls made a small model of a ship, which he said could be made to go into any port or harbor or river against wind or tide. And the government gave him permission to try it. That is they gave him a patent. But we do not find that he ever built a real boat like the model. And people everywhere laughed at him for thinking of it.

"A little later someone in our own country tried to make a steamboat. His name was William Henry. He was born in Chester County, Pennsylvania. He learned

the trade of gunsmith. When he was driven from his home during one of the Indian wars, he settled in the town of Lancaster.

"In 1760 he went to England on business. There he heard about James Watt, and became much interested in the idea of using steam to drive boats.

"When he came home he made a steam-engine. He placed it in a boat with paddle-wheels. He tried to make the boat go on the river near his home. But for some reason it sank.

"He still believed, however, that a steamboat could be made which would go. And he told people that some day boats of that kind would be seen on the waters of the Ohio and the Mississippi Rivers. This proved to be true.

"All this time people in France and elsewhere were trying too to make steamboats. And different boats were made in different parts of the world. All of these boats could be made to go at a rate of a few miles an hour.

"In America there was John Fitch, who lived in Bucks County, Pennsylvania. He got a patent from the state of New Jersey, and later from Pennsylvania. In 1790 he had a boat carrying passengers on the Delaware River from Philadelphia to Trenton.

"But probably the best-known of these early builders of steamboats was Robert Fulton. He was born in

Lancaster County, Pennsylvania, and was often at the home of William Henry. There he saw the models of boats, which Mr. Henry had made.

"He spent some time in France and also in England. And he learned all he could about boats in both places.

"In 1807 he and his partner, Mr. Livingston, built a larger steamer than any that had been built before. It was called the Clermont. The hull was one hundred and thirty-three feet long, eighteen feet wide, and nine feet deep. It was launched on the East River, New York. It made a trip to Albany, going one hundred and fifty miles in thirty-two hours. It came back in thirty hours.

"This was the first voyage of any length made by a steamboat of any size. And so Robert Fulton is said to be the man who really made it possible for us to travel on the water by means of steam.

"If James Watt could be called the inventor of the steam-engine, then Robert Fulton could be called the inventor of the steamboat.

"From the time of Fulton on, steamboats began to be used everywhere. In 1812 a steam ferry-boat was used between New York and Jersey City. And other boats were built to use on the rivers in the west.

"The War of 1812 was going on at this time. Fulton thought of making a steamboat which would carry guns and could be used in the war. Such a boat was built and finished in 1814. It cost \$320,000. The hull was double,

one hundred and fifty-six feet long, fifty-six feet wide, and twenty feet deep. It was called Fulton the First. This was the first time steam was used in the Navy.

"A great many other men were studying steamboats at the same time that Fulton was. Different people thought of different things that could be used to make them better. One of these people was John Stevens.

"Robert Stevens, a son of John Stevens, was also a great ship-builder. We owe much of the success of steamboat building to these two men. Robert Stevens was the first man to use hard coal in making steam."

"But Daddy, when did they first use steamboats to cross the ocean?"

"The first steamboat to cross the ocean from America was the Savannah. It started from Savannah, Georgia, and went to St. Petersburg, Russia, in 1819."

"And they've been going ever since, have they?"

"Well, yes. But still it was a good while before people believed that they could cross safely. As late as 1838 some people said that the only way would be to stop for coal either at Newfoundland or the Azore Islands. And yet that year two ships made the trip.

"One started from Ireland and one from England. They both reached New York the same day. It took one of them nineteen days and the other fifteen days to cross.

"When they reached New York people flocked to see them. A salute was fired by the forts. And boats of all kinds came out into the harbor to meet them. That was the real beginning of ocean travel by means of steam. It has never stopped since."

## CHAPTER XXI

There was a passenger on board the ship whom Ted soon got to know. People called him the Captain.

When he was a young man he had sailed all over the world. He had brought tea and carved ivory from China and Japan. He had seen black men on the coast of Africa, with their skin shining in the sun; and Laplanders up in the frozen north, who wore the furs of animals to keep warm.

But he was not a young man now. His hair was white and his shoulders bent. And he was done with the sea. He was going to live with his daughter and his grandchildren in England.

There was nothing, however, that he could not tell you about the ocean. And he and Ted became fast friends.

Ted could not get done watching the waves. He remembered how he and Mother and Daddy had gone in bathing at the seashore. And how the breakers had come dashing in, covered with white spray. Daddy had taken them out beyond the breakers where they could just feel the swell of the water as it rose and fell, and rose and fell.

It was that same kind of waves that they saw now. And the ship as it went on its way rose and fell, and rose and fell with them. It was a very gentle motion, for they were having what the Captain called a calm passage.

But the sea was not always calm, it seemed. Sometimes the waves rose very high and washed clear over the

decks of ships. Then the passengers got frightened and went below. Ted hoped this would not happen to the ship they were on.

"What makes waves, anyhow?" he asked.

"Wind," answered the Captain. "The wind is always blowing somewhere."

"I wonder what makes the wind blow."

The Captain could explain this too. "Heat," he said.

"Warm air," he went on, "is lighter than cold air. And so it rises. Then the cold air rushes in below to take its place."

Ted remembered this. He remembered how a cold wind blew out from the mouth of a cave. And how the warm air rose like steam from the top.

"This can happen anywhere," said the Captain. "And whenever it happens it starts the wind to blowing. But besides these winds that may blow anywhere, there are certain winds that blow from one direction all the time. We call them trade winds.

"You know that the earth is round like a ball."

"Yes," said Ted. "And it keeps turning all the time."

"It does. It spins like a top. On the middle of the top, as it spins, the sun shines all the time. We call that part the equator. It is very hot there."

"But at the top and the bottom the sun does not shine. We call these parts the North and the South pole. It is very cold there."

"I know," said Ted. "I learned that in school."

"And so," said the Captain, "there is heated air rising from the equator, and cold air rushing in from the poles to take its place. But the wind does not come straight down from the north, and straight up from the south. Can you guess why?"

Ted shook his head.

"For the very reason that we just talked about. The earth spins so fast that it turns the winds a little out of their course. It makes them blow from the north-east and the south-east. These are the trade-winds."

But there was something else Ted learned about stranger even than waves and trade-winds. It was the Gulf Stream.

"The Gulf Stream," said the Captain, "is a river in the ocean."

"A river!" cried Ted.

"Yes, a river bigger than the biggest river that flows through any land."

"But—but—it couldn't flow through water."

"Yet it does. Its banks are cold water. And its bottom is cold water. But the Gulf Stream itself is warm. It starts in the Gulf of Mexico, and it flows towards the North pole."

Ted thought that this could not be. But he found it to be so, because one day it was very warm on shipboard. Mother took off the furs she had been wearing and put

on a summer dress. People talked about the change of weather. But the Captain said they were crossing the Gulf Stream.

Ted wanted to know all about it.

"The Gulf Stream," said the Captain, "is so different from the ocean that it is even of a different color. For some distance after it starts it is a deep blue. And you can see it flowing through the light green water of the ocean. It carries seaweed with it too."

"About half-way up there is a place in the ocean where this seaweed collects. More than four hundred years ago Christopher Columbus set out from Europe to see if there might be another land across the sea. When he came to this place, his men thought that they could go no farther. It was so covered with seaweed that it looked as if they could get out and walk on it. They were sure that the ship could not sail through it. But it did. And at last they found the land we call America. And there were only Indians living on it then. This place filled with seaweed is called the Sargasso Sea."

"Is that the end of the Gulf Stream?"

"Oh, no indeed. It keeps on flowing north until it comes to the Banks of Newfoundland. Here it meets a cold stream of water coming down from the North pole. This cold stream of water often carries icebergs. These icebergs are melted by the warm waters of the Gulf Stream. And the earth and stones and gravel in them

pile up on the Banks of Newfoundland. This piling up of stones and gravel year by year has made the banks of Newfoundland very high."

"Does the Gulf Stream stop there?"

"No, it turns from there to the east and flows across towards Ireland. Ireland, as you know, is one of the British Isles. England and Scotland are the other two. Here the Gulf Stream divides. Part of it goes north and is lost in the frozen seas. The other part goes south and is lost in the warm waters of the Bay of Biscay."

"Where is the Bay of Biscay?"

"Off the coast of France."

"Is it warm in France?"

"Yes. It is warmer than that part of America which is just across the ocean from it. And the British Isles are warmer too. If we could throw a stone straight across the ocean from Ireland it would hit America north of the United States, away up in Canada. They have very cold weather there. Yet in Ireland the weather is so mild that the grass is green most of the time. It is as green as an emerald. So people have called Ireland the Emerald Isle.

"Another thing that makes the grass so green is that the air is very damp. For the air rising from the warm Gulf Stream has much water in it. So the weather, or climate as we say, of the British Isles, is warmer and damper than that of America."

"Gee," said Ted. "That's funny."

"What kind of heat do you have in your house?" asked the Captain. "Hot water?"

"Ye-yes," said Ted. He wondered what the Captain meant by such a queer question.

"And you have a furnace in your cellar, haven't you?"

"Yes."

"Well, the Gulf Stream is very much like your heating-plant. The furnace is the equator. The Gulf Stream is the water in the pipes. It reaches all the way to England, Ireland and Scotland. The people there know it does because they sometimes find drift-wood on their shores that has come all the way from the Gulf of Mexico.

"And they are very glad that nature has built such a splendid heating-plant to give them a good climate."

## CHAPTER XXII

Ted often wondered what made the ocean look so different at different times. Sometimes it was blue, and sometimes green. On a dark day it was just a kind of dull brown.

The Captain said it all depended on the way the sun shone on it; and that a glass of sea water was just as colorless as any other kind of water.

He said that there were many things though that might make it look different. If the water was shallow and there was white sand at the bottom, it would be a light green. If the sand was yellow, it would be a deeper green. If there were rocks below, the water would look darker. Indeed sailors often found out where the rocks were by watching the color of the water.

He said too that some bodies of water were named according to their color. The White Sea was named white because of the ice in it; and the Black Sea black, because of the storms which often made its waters look black. The Red Sea was so called because of a red plant which showed through the water.

Another thing the Captain told Ted about was the saltiness of the sea. Of course Ted knew that the sea was salty because all the rivers flowing into it had carried with them some of the soil or rocks over which they had come. Daddy had told him that. But there was more to learn.

The Captain said that there was also something sticky in sea water. This was because of the plants and the tiny animals that had died there.

He said too that the sea was more salty near the equator, and less salty near the poles. And that the great Mediterranean Sea was more salty than the ocean.

The Black Sea, he said, had less salt than the ocean. And the Dead Sea had so much salt that a man could float on its waters without sinking, like a cork in a bathtub. It was six times saltier than the ocean.

This saltiness of the ocean was a good thing, he said, because it helped the ships to keep afloat. It also helped the streams in the ocean, such as the Gulf Stream, to flow. It also kept the water from freezing. For salt water does not freeze as soon as fresh water. This is because salt helps the rays of the sun to find their way down into the water and warm it.

There was another strange thing to be learned about the ocean. That was its tides. They were caused, the Captain said, by the sun and by the moon.

He said that the sun and the moon tried to draw the water up from the earth. Of course they could draw it only a little way. But the moon could draw it farther than the sun. This was because the moon, although smaller than the sun, was nearer to the earth.

But with all their drawing, the best they could do was to cause two pairs of waves to rise. These two pairs of

waves travelled right around the earth, wherever there were oceans.

If there were nothing but oceans, they could keep right on travelling. But when they ran against the land, they just dashed high up on the beach and then rolled back again.

"Oh, I know," cried Ted. "When we were at the seashore we couldn't go in bathing late in the afternoon because the water was too high."

"Exactly," said the Captain. "That was high tide. And when you did go in, in the morning, it was low tide. This thing of high tide and low tide is caused by the drawing power of the sun and moon."

"Does the water do that everywhere?"

"Everywhere more or less. In the South Sea Islands the tide hardly rises higher than the length of your arm. But in the Bay of Fundy it rises fifty feet or more, as high as a house."

"Once a ship was cast upon a rock near there. When morning came the sailors found themselves and their ship away up in the air, with the water far below them. You see it was low tide by that time."

"Gee," said Ted, "that was funny."

"When the tide strikes the shore with a great swishing noise, it is called surf. This surf is very strong in some places. If there is a high wind, the surf is just so much the stronger."

"When the water is gathering itself up to strike the shore, it is called a billow. These billows are sometimes very high. They look like great green mountains. And just before they strike, they curl over at the top and send the spray dashing away up on the beach."

"I know," said Ted. "I've seen them."

"Away down at the lower end of Africa, at the Cape of Good Hope, the billows are so high sometimes that one ship cannot be seen from another ship, if there is a billow between them. They rise as high as forty feet.

"Even where the billows are not so high, they can dash very hard if something gets in their way. In the English Channel there is a great tower. It is called the Eddystone Lighthouse. A very bright light burns there to warn the ships of the rocks, and to guide them into the Channel.

"Sometimes the waves strike it so hard that the spray rises one hundred and thirty feet into the air and falls back on the roof of the lighthouse.

"If the waves dash in between rocks, they form what we call whirlpools. These are very dangerous to ships.

"There is a famous one which the old Greeks knew about. It is formed between two rocks which they called Scylla and Charybdis. They were very much afraid of this whirlpool."

Ted thought that this was very interesting. But in a minute he forgot all about it. For everyone was crowd-

ing to one side of the deck, and he and the Captain went too.

They wondered what was the matter. They soon found out. It was an iceberg the people were looking at.

Ted was so excited that he could not keep still, but kept jumping up and down. For there in the distance was a great white mountain of ice. It was said to be two hundred and fifty feet high.

Ted wondered what would happen if it ever struck the ship. The Captain said it could crack a ship as easily as you could crack an egg. But of course it did not strike the ship, for they kept out of its way.

It was wonderful to look at though, so white and dazzling. And where there were cracks in it, it was a deep blue.

Strangest of all, the Captain said, they were only looking at the top of it. The biggest part of it was under the water.

As long as they could see it, they watched it. And long after that Ted kept thinking about it. It was the most wonderful thing he saw on the trip across.

## CHAPTER XXIII

"How deep is the ocean?" asked Ted one day.

The Captain smiled.

"A good many people have wondered about that," he said, "for a good many years."

"Is there any way to find out?"

"Yes, in some places."

"How do they do it?"

"They have tried to do it in several ways. Time and again sailors from their ships have dropped a line overboard. They thought that in this way they could measure, or as we say fathom or sound, the sea."

"And could they?"

"Not if they were far out. If they were near shore the lead at the end of the line would touch bottom. Then they knew how deep the water was in that place."

"But when they got away out upon what sailors call 'blue water,' this way of measuring or fathoming the ocean would not work at all."

"Why not?"

"Because when the line got down a certain distance it was caught by the streams of the ocean and carried this way and that. It never reached bottom at all."

"That's queer," said Ted.

"They tried every way they could think of. They used a cannon ball for a weight. They used twine and they used silk for a line. But they never could touch bottom."

"They even fastened a kind of screw to the weight in such a way that it would measure the number of times it turned in going down. By counting the number of turns it made they thought that they could tell how far down it had gone.

"This worked very well in shallow water, but not out in the middle of the ocean. For if they used a small line, they could not draw it up. And if they used a heavy line they could not make it go down.

"They tried other things too. They sent down gunpowder. This, they thought, would blow up, or, as we say, explode, at the bottom of the sea. And by noticing how long it took for the sound of that explosion to reach them, they could tell how far down it was.

"But they never heard it at all. Doubtless the gunpowder did explode down there at the bottom of the sea. But with so much water in between, no sound of it ever came up to the top.

"It seemed as if old ocean was laughing at them. Try as they would, they could not make her give up her secrets.

"But all this trying did some good. People learned a good deal about the streams in the ocean. If they could not reach the bottom, they at least learned where they could not reach it and why they could not reach it.

"And all the time men were working, trying to make better and better lines to sound or fathom with. At last

someone made the best one of all. It was not really a line at all. It was an iron rod. This rod passed through a cannon ball. And at the bottom of the rod there was a cup filled with soap.

"This was put together in such a way that when it struck the bottom, the cannon ball would come loose and stay there. The iron rod with its cup of soap could be drawn up.

"In the cup of soap, sticking fast to it, could be found any little plants or animals which happened to be on the bottom where it struck. In this way they found out two things; where the bottom of the ocean was in any particular place; and what was on the bottom of the ocean in that place.

"My," said Ted, "wish I could see some of those things. Then they really did find out how deep the ocean is."

"In some places. The deepest place they could measure was just south of the Grand Banks of Newfoundland. That is the place you remember, where the Gulf Stream turns and where the cold Polar stream comes down. And where the earth and stones and gravel from the icebergs pile up.

"It is deeper still farther east. But no rod has ever been made that could measure it. The deepest place that has been fathomed is five miles."

"Five miles?" cried Ted. "Five miles *deep*?"

"Five miles deep," said the Captain.

"Five *miles*?" Ted still could not believe it. This ocean underneath them five miles deep!

The Captain smiled.

"Did you ever stop to think," he asked, "what the bed of the ocean would look like if we could drain off the water?"

"No," said Ted.

"Well," said the Captain, "it would look like a big gash in the earth. Suppose you took an apple, which is round like the earth, and cut a piece out of it right down to the core from the stem end to the blossom end. That would look something like this gash in the earth. For it is cut probably from the North pole to the South pole.

"Only it is not a clean cut such as you would make with your knife. It is very rough and jagged. That is why there are mountains and valleys and plains in the ocean."

"Mountains?"

"Certainly. When you come to a shallow place in the sea you are crossing a mountain. When you come to a deep place you are crossing a valley. If the mountain is very high, it may stick clear up out of the water. Then it is called an island."

"Gee," said Ted. "I never thought of that."

"If we could look into this gash in the earth, we should see many wonderful things. We should see the bones

of animals such as we never saw living on the earth. And the timbers of ships that have sunk.

"We should see pearls and precious stones; and plants; and shells which once held living animals."

"Held animals?"

"Yes. Didn't you know that shells were the homes of animals?"

"No." said Ted.

"I'll tell you what happened years ago. People had learned to send messages from one place to another by means of wires strung across the land. They called these messages telegrams. And they called the wires telegraph wires.

"Then they wanted to send messages across the ocean in the same way. But they could not do it because there was no place on which to hang the wires.

"So they thought that they could put the wires inside of a twisted cable, and lay that cable on the floor of the ocean, if they could find a place high enough to reach.

"They made soundings with the iron rod I told you about, and found that there was such a place between Cape Race in Newfoundland and Cape Clear in Ireland. They called it a plateau, because a plateau means a high level place. And because they could send telegrams by means of the cable which they laid, they called it the telegraphic plateau.

"This cable has been a wonderfully good thing, because now people can send messages back and forth from one side of the ocean to the other whenever they want to.

"But besides that, another good thing came out of it. The iron rod with its cup of soap brought up sand or clay from the bottom of the sea. This sand or clay was sent to learned men in America and in Europe.

"They looked at it through the microscope and found it was not sand nor clay at all. It was a kind of dust of sea shells. These shells were so small you could not possibly see them except through the microscope. And yet in each shell an animal had lived.

"This was the first chance they had had to look at such shells. And they studied and studied and studied them. They felt that if they could just go down and look at the bottom of the sea they could read a great big story of life on the earth. For there the story of the shells is written.

"We think that there are many birds flying through the air. And many animals walking about on the earth. But these birds and these animals are as nothing at all to the little living things in the ocean. There are millions and millions of them. And they are hidden from us forever by the waters that cover the sea."

The Captain stopped and looked away out across the water. His eyes were as blue as the sea itself. And the look in them was as far away as the farthest waves. He

was saying something to himself. It sounded like "the works of the Lord, and his wonders in the deep." Whatever could he be talking about?

Suddenly he turned. "Child," he said, "do you know the names of the oceans?"

"Ye-yes sir," said Ted. "I—think so."

"Let's name them."

So they named them together. Atlantic, Pacific, Artic, Antarctic, and Indian Oceans.

## CHAPTER XXIV

Ted kept wondering about those living things in the ocean. One day the Captain told him about them.

First they took a drop of water and looked at it under the microscope. It looked just cloudy at first. Then they saw that there were things floating and swimming about in it. Some of these things were plants and some were animals. They were so small you could not see them at all without the microscope.

The Captain said that there were millions of these little plants. They grew as close together as trees in a forest. And the little animals could swim all around through them, just as birds fly about the trees up on the land.

"These little animals not only swim around," he said, "but they also fight with each other. They try to catch each other. And sometimes they kill each other.

"They also stop swimming sometimes and catch hold of the rocks beneath them. There they build houses for themselves and live in them. When they die their houses stay right there on the rocks.

"And then some day, perhaps, when the tide goes out, the rocks near shore lie bare. And boys and girls wade out and gather these little houses from the rocks, and bring them in and play with them.

"Or a diver dresses up in his diving suit and goes down into the ocean. He has to wear heavy lead shoes or he could not stay on his feet in the water. And he

has something round on his head, called a diving-bell. This has glass in it for him to see through. And there is a tube fastened to it. Through this tube he gets fresh air to breathe.

"He gathers up all the little houses or shells that he can, and then he pulls a cord. The people up above know then that he is ready to come up. So they pull him up quickly. And they take the shells and send them to the men who study such things."

"These men do not always agree about the things that live in the ocean. Sometimes they look at something which floats in water, and one man says it is a plant, while another says it is an animal."

"There are plants which float about so freely that they seem like fish swimming. And there are little animals which hold so tight to the rocks that they seem like plants growing."

"You cannot tell them by their shape either, for they have no arms nor legs. Not even heads, perhaps. It is very hard to tell where plant life ends and animal life begins."

"The best way to study some of these plants and animals is to put them into a large tank. We call this tank an aquarium."

"I know," said Ted. "I've been to the Aquarium in New York."

"What did you see there?"

"Why—why—just seaweed. And little fishes."

"There is much more to see if you stay long enough. Indeed you could spend your whole life—if you wished to—just studying seaweed."

Then the Captain showed him pictures of life in the ocean taken under the microscope. There were kinds of seaweed that looked like moss, or like ferns. Indeed seaweed, he said, was the moss and the ferns of the ocean.

And then the little animals! There was one kind that grew by dividing itself in two. This he saw under the microscope himself. It was the shape of a bean. After awhile it grew narrower in the middle. At last it grew so narrow that it came apart entirely. Then there were two beans instead of one.

It was very queer. But this was not the end of it. For each of these two beans, the Captain said, would make two more. And those two, each two more. And so on—and so on—

"Why, I should think," said Ted, "the ocean couldn't hold them all."

"Well," said the Captain smiling, "you must remember they are very small."

He looked at the Captain and then at the microscope. He had forgotten all about that. He had been as interested in them as if they had been cats or dogs. And yet they were so small that you could not see them

without a microscope. They had a queer name. He did not try to remember it.

But there was another kind he could remember easily. These were the sponges. He knew what a sponge was because the little girl next door had one. She had a slate. She would draw pictures on it. Then she would take her sponge and fill it with water and wash off the pictures.

The sponge held a great deal of water. Sometimes it dripped all over her clean dress. Then Jane would scold her. And she would cry. He wished he could see the little girl next door. He wished he could see her right now. He wanted to tell her all about the sponges.

It was a long time, it seemed, before people could tell whether a sponge was an animal or a plant. It grew fast on the rocks like a plant. Yet it had openings in it, and through these openings it seemed to breathe. So they decided at last that it was an animal.

Yet it was the strangest kind of animal, for it never moved from the rocks where it was fastened. Whatever it got to eat, it got from the water around it. It could not swim off to hunt food. It almost seemed to be half-way between a plant and an animal, if such a thing could be.

It had no head nor arms nor legs. All it had was openings through it. In and out of these openings the sea water flowed. And from the sea water it got its

food. So you might call it an animal that was all stomach.

A sponge might be small or large. There were more than two hundred different kinds that people had counted. Some were very small indeed. And some grew as high as Ted's head, so the Captain said.

But they were all alike in one thing. They could hold water. And so, many years ago, people began to gather them. They used them to wash things off with, just as the little girl next door washed off her slate.

Some sponges grew in shallow water. These they could reach with a long-handled fork. But the finest ones grew in deep water. Here a diver would go down with a knife and cut them off. Many people made their living by fishing or diving for sponges and selling them.

There were little animals which could sting you like a nettle, if you touched them in the water. There were others which looked like little umbrellas floating about.

There were some that lighted up the sea when they floated on it. These were joined to each other, and their bodies glowed like lamps, so that at night when they rose to the top they looked like long ribbons of fire.

But the most interesting of all were the ones who made coral. Ted had often seen coral. Mother had a piece of it lying on her desk at home. It looked like a branch of a tree, only smaller. And it was very white. If he

had thought about it, he would have said that it was a branch from some plant.

Other people used to think that too, the Captain said. One day a man put a branch of it in a vase of water. He thought he saw flowers on it, and he wanted to see them bloom.

But they were not flowers at all, he found. They were animals. And they had built the branch on which they lived.

This was strange enough. But the Captain told him something stranger still. He said that they not only built small branches. They built whole islands too.

"Islands?" said Ted.

"Yes, islands big enough for people to live on."

"Why, how could they?" cried Ted. "How big are they?"

"Not big at all. So small that you would need a microscope to study them."

"And they build islands?"

"Yes, they can do it because there are so many millions of them."

"How do they do it?"

"Well, they begin by taking hold of the rock. Then they build out branch after branch. They keep on building, round and round, and round and round. The coral above grows out of the coral below. And finally the island comes up out of the ocean."

"Does it look all white like the coral on Mother's desk?"

"No, not all white. For sand and seaweed and other things gather there. The ocean brings them. And seeds are dropped there too. So that after awhile plants and trees grow up. And when you see a coral island it looks much like any other kind of island."

"Gee," said Ted, "that's queer."

"There are many kinds of coral. But it is only found in the warmer seas. Here men go fishing for it, just as they fish for sponges."

The Captain showed Ted some coral. He was taking it to his grandchildren in England. Some of it was red and some was pink and some was white. He gave Ted a piece of the red coral to take home with him.

The time was growing very short now. Soon they would be in England. Ted was almost sorry. There were so many things still to be talked about.

He wanted to ask the Captain about sword-fish and cuttle-fish and all the other kinds of fish he had never seen. And about whales and where they come from. But there was not time enough for everything.

And so they said goodbye. And the Captain went one way to see his grandchildren and their father and mother. And they went another to begin their trip through England.

## CHAPTER XXV

Ted and Daddy and Mother saw many interesting things in England, and also in Scotland and Wales. They saw the river Clyde, where so many big steamships are built. And they saw the tomb of James Watt, who made steamships possible, in Westminster Abbey.

There were kings and queens and other great men and women buried there. And people must have thought that James Watt was a great man too. For the words on his tomb said that the king and the people of England had placed it here, not to make others remember his name, for his name could not be forgotten. But that they had placed it there to do honor to a man who was a real friend to mankind.

From England they went to France. After that they went to Italy. Here Ted saw many things that he had only heard about before. He saw a great volcano. And he saw what the lava from it looked like after it was cold and hard.

They bought a little pencil made of lava. They also bought a string of Naples coral. It was lovely and pink. Ted was going to take it home to the little girl next door.

He wished he could see the little girl. He had so many things to tell her. He was afraid he might forget them before he got home.

But the country he took the most interest in was Switzerland. It was so different from any place he had ever seen before.

There were high mountains there called the Alps. These mountains divided Switzerland from Italy. They were very high indeed, and the top of them was covered with snow.

There was a tunnel through them, and the train went through this tunnel. But years ago, so Daddy said, there was no tunnel there. Then people had to climb to the top. This was dangerous, because the snow was deep. And sometimes travellers would get lost in it. They might have frozen to death there but for one thing.

On top of the mountain was a place built in honor of a very holy man. This man was named St. Bernard, and he had died many years before.

To this place travellers could come and rest and get warm. And there they kept dogs. These dogs were trained to go out into the snow and look for travellers. If anyone lost his way, the dogs would find him. If he fell, the dogs would drag him up and bring him in.

They had a chance to see some of these dogs. They were very big and shaggy. And they had blue eyes. Mother said they were just dear, and she wished she could hug them. But Daddy said they were fat and lazy because they had nothing to do.

Ted was glad they had nothing to do. He was glad that he and Mother and Daddy did not have to climb the mountain and get lost in the snow, but could go straight through it on a railway train.

People did climb mountains though in Switzerland. They did it on purpose. And it was very hard to do, because the mountains were so high and so slippery with ice and snow.

'There were men called guides who made a business of taking people up these mountains. They would tie the people together with ropes. Then the guide would go ahead with a sharp-pointed stick. He called this stick an Alpinestock.

He would stick it into the snow to steady himself as he climbed. And the whole party would climb after him. Daddy wanted to go with a party right away. But Mother would not let him.

There were lovely lakes too in Switzerland. One of them was called Lake Lucerne, and one, Lake Geneva. There were many others too, besides these. They were all very deep.

Lake Lucerne was green, while Lake Geneva was very blue. This was because the water in Lake Geneva was very pure. In Lake Lucerne there was plant life, which gave it its green color.

There were rivers too in Switzerland. Two of the principal rivers of Europe begin, or rise, in the mountains there. These rivers are the Rhine and the Rhone.

Ted was interested in these because he remembered how a river cuts its path. He could almost watch a river doing it here.

Because of the high mountains the streams run very fast. One of them, which goes on to join the Rhine, has cut a deep valley, almost a gorge. High up on the banks of it are little towns. These towns are in danger. The rocks are cracking underneath them. That is because the river is cutting the rocks away so fast.

In another part of the River Rhine there are steps which the river has built along its banks out of the mud which it has carried and left there. Ted remembered how Daddy had told him about this once.

On these steps people had built houses. But after that the river began cutting down its path so fast that the steps crumbled. Then they had to move their houses back to get them on safe ground.

All these things made Switzerland seem like a strange and wonderful country. Daddy said it was a wonderful country. He said it was like a page out of the story of the earth. This was because it showed so plainly the work of glaciers.

“Glaciers?” said Ted.

“Yes. Do you know what a glacier is?”

"No," said Ted.

"A glacier is a river of ice."

"A river of ice! But a river of ice couldn't move."

"It does though. Very slowly. But it moves."

And then Daddy told him a long story about glaciers that went away back to the beginning of things before any people lived on the earth.

"In the first place, while the crust of the earth was still cooling, it formed in folds or ridges. This was because it was driven up and down and sideways by the heat. It may have looked something like a cake baking in the oven.

"One of the folds or ridges hardened into these mountains, called the Alps. They may not be just the same shape now that they were then, because many things have happened to them since. But they have been here ever since that time.

"After the steam which once covered the earth cooled off, it became water. After the water cooled enough it became ice. This ice was found not only at the North and the South poles, where there is always ice now. It was found in other places too.

"There was what was called an ice age, when ice covered nearly the whole of Europe and of our own country of America. We know this in different ways. It left marks upon the rocks which we can see to-day. And it left traces of plants and animals, which live only

near the North or South poles. If there had not been very cold weather and a great deal of ice, they could not have lived there.

"It seems that the ice melted and the country had warmer weather once more. For we find the remains of plants and animals which live in a warm climate. Then later it froze again, and again melted. This may have happened two or three times.

"But at last it melted and never froze again, except in the mountains or in countries where they would naturally have cold weather. If we want to know though what the ice looked like in those countries which are now warm, we have only to look at a glacier. And there is no place where we have so good a chance to look at a glacier as in Switzerland."

And then they went one day as near as they could to the end of a glacier. It was indeed a river of ice. And where the ice melted and ran down, a river of water began. The River Rhone began this way, Daddy said, and so did many other rivers.

These mountains, the Alps, were very high. And the valleys in between were narrow. The ice was almost shut in by the mountains, and moved slowly through the deep narrow valleys.

The glacier they looked at ended in an arch of ice. Out of this arch came the water of the river. It was formed by the constant melting and dripping of the ice.

The arch looked solid. It looked as if you could walk across it. But Daddy said that that would be dangerous. He said that sometimes in summer it would crumble and fall with a crash.

Near to the arch were piles of little stones. The glacier had carried these down and left them there when it melted. They were called moraines.

"A glacier always does that," Daddy said. "And wherever we find such piles of stones, we know that sometime there has been a glacier there."

Farther up, where the ice had not melted, they found many beautiful shapes. It looked as if some giant had tried to carve figures out of the ice, and had piled them up there for everyone to see.

This was because the ice was broken in sliding down between the sides of the valley or gorge.

After awhile they came to a little hut on the mountain, where they stopped and rested. Then they went on along the mountain side until they came to a place where they could cross the glacier.

It seemed very strange to walk across a river of ice. But the guide said it was safe enough, if they did just what he told them to. There were big cracks in the ice. These were called crevasses. But the cracks were not so big as they got nearer to the other side. At first the ice was dirty. Afterward it was clean and white like snow.

When they got to the other side they climbed a steep mountain. Here the view was beautiful. But they did not stay there. They walked on up.

Coming down the slope was a little glacier. It was going on to join the big one, just as a small stream joins a river. There was a big rock on it. While they looked this rock loosened and went rolling down over the ice. This is the way a glacier carries rocks, big and little, and leaves them where they fall.

To the right was a big crack in the rocks. In this crack was a pillar of stone. The guide led them to this pillar. It was a very hard climb, but he knew just how to get there.

From there they could see the whole glacier below. They found that it branched out into three parts. In some places it was a smooth white river of ice. In other places there were frozen waterfalls that reminded you of Niagara.

When they got back again to their hotel, Daddy said that some people climb much higher than they had gone.

"When they do that," he said, "they find all kinds of ice mounds and ridges. They find deep cracks or crevasses too. Some of them they can hardly cross."

"Sometimes they have to use an axe. They cut steps in the ice and climb up by means of them. When they come to a crevasse, they can sometimes cross it on a bridge of snow. But this is dangerous. For the snow may crumble and throw them down into the crevasse."

"Men have taken great risks in order to find out all they can about glaciers. They have walked along narrow ice walls with deep crevasses on each side. They have seen the blue light shining up from these crevasses under the blue sky above.

"They have crossed a frozen glacier to an island where flowers bloomed. They have looked at the great mountain near it. And down this mountain they have seen the snow roll with a noise like thunder.

"Such a snowslide is called an avalanche. The guides are careful to keep out of the way of one. If they did not, the snow might bury them.

"Men have found out too, how fast a glacier moves. Once a man built a hut on the ice. This hut moved, and he kept watch of the distance it went. It took it three years to move three hundred and thirty feet.

"It was found that the middle of a glacier moves faster than the sides. Just so the middle of a river flows faster than the sides. But it would take a glacier some time to catch up with a river, wouldn't it? When it only moves a hundred feet or so in a year. One man who measured it said that a glacier moved less than two inches a day.

"Sometimes the men who were watching a glacier would hear sharp sounds like pistol shots. After awhile they would find out what caused it. It was the ice cracking from the bottom up. The crack would be very

small at first. But as the sun shone on it and melted the ice, it would grow bigger and bigger. Finally it would become a crevasse too wide to cross.

"A large crevasse is beautiful. It always has that strange blue light in it. And icicles hang over the edge, as long sometimes as thirty feet."

"Sometimes they found a square stone standing away up like a table on a pillar of ice. This was because the sunshine could not get through the stone to melt the ice underneath. So it melted the ice all around, and left just the pillar of ice holding up the stone."

"People have studied glaciers not only in Switzerland, but also up in the Artic ocean near the North pole. Here the ice moves slowly too until it reaches the warmer water of the Atlantic or the Pacific ocean. Then it melts and big pieces of it break off. These pieces are the icebergs that float in the sea."

"Oh," cried Ted, "like the one we saw?"

"Exactly. An iceberg is the broken end of a glacier."

There was something else that was interesting to see in Switzerland. There were rocks so round and so polished that you felt that they must have been carved on purpose. Glaciers had carved them, Daddy said.

The ice had ground them, round and round, and round and round, and then left them. There were no glaciers near them now. But there had been once.

Ted thought that this was very strange. But Daddy said that you could find these round rocks in many places. You could find them in America right near home. And you knew that wherever you found them there had once been a glacier.

It made Ted feel queer to think that the countries which are now warm had once been covered with ice. "How long ago was that, Daddy," he asked.

"Oh, many thousands of years ago. Perhaps before there were any people living on the earth."

Ted began to feel queerer than ever. He did not like to think about a time when there were no people living on the earth. He liked people.

He liked rocks and rivers and clouds and glaciers. But he liked people best of all.

And he liked people that he knew. He liked Uncle Bob and Nora and the little girl next door. He wanted to see them—right now.

He wondered how the hollyhocks looked. And if that opening in the hedge was still there. He wanted to go straight home and find out.

\* \* \* \* \*

It was still there.

Uncle Bob met them at the boat. And Nora met them at the front door.

And then Ted ran through the house and out into the yard. The hollyhocks were still blooming. The open-

ing in the hedge looked just the same. The little girl was there too. Even that everlasting doll was there also.

She dropped the doll when he put a little white box into her hand.

Then he began to talk about everything at once, coral islands and the Captain and St. Bernard dogs and crevasses, all in one breath.

She did not hear a word of it.

"Don't you wish you'd seen them?" he asked.

She had the box open by this time.

"Oh, oh, oh," she cried, dancing up and down.

"Are you glad to see me back?"

She turned and raced for the house, the box in one hand, the string of coral in the other.

"Daddy, Mother, Jane," she called.

Ted raced after her.

"Did you miss me?" he said.

The door banged after her. He never did find out.

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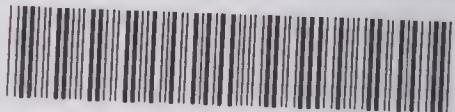
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